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NEW YORK, MARCH, 1888.

WE have received two copies of the work on bridge construction which was mentioned in this column last month. Both of them were received too late for use in the present issue, but we hope to reproduce some extracts from the book hereafter.

THE Panama Canal, or rather its management, is very severely criticised in a recent number of *L'Economiste Français*, a high authority on economic questions. M. Leroy-Beaulieu, the Editor, considers it impossible for the canal to be completed within five years, even on the new plan with locks, and he is unwilling to accept M. de Lesseps's promises either as to the time or the amount needed to finish the work. He points out also that there is a much larger sum to be provided than the Canal Company is willing to admit, and that it can be raised only with great difficulty.

The canal seems to be faring badly on all hands just now, and the collapse of the present company seems to be only a question of time. It is to be regretted that so great a project had not fallen into more capable hands.

THE question of heating cars is briefly discussed by the New York Railroad Commissioners, in their report for 1887. After referring to the act passed by the last Legislature of the State, which requires the adoption of some method of heating by steam from the locomotive, the Board say that it will require some time and more practical experience to determine which of the systems already proposed is the best. They refer to the efforts made by some of the leading railroad companies to secure a uniform coupling for steam pipes, and recommend the adoption of such a coupling.

The Board, apparently, is not altogether of the opinion that steam heating will prove the best, and refers to several systems of heating by stoves with coverings of sufficient strength to resist breakage with provision of extinguishing the flames in case of accident. So long as the present law is in force, however, the discussion of this is hardly necessary.

In this connection the Board very sensibly calls attention to the necessity of proper ventilation of cars in connection with any system of heating, and the report refers with some severity to the difficulty which has been experienced in inducing railroad companies to take any steps in that direction. This question of ventilation the Board considers almost equal in importance to that of safety, in any discussion or settlement of the heating question.

THE great work undertaken by the New York Railroad Commissioners some time ago of procuring strain-sheets of all the railroad bridges in the State is not yet entirely completed. It was expected that the bridge report would be submitted with the annual report for 1887, but its preparation was not completed in time; it will, however, appear shortly as a supplement.

The amount of labor required in the preparation of this report has been enormous, as engineers will readily admit if they consider for a moment the mileage of railroad in the State and the number of bridges.

THE Russian Government has finally granted the concession for the building of a pipe line from the oil fields of Baku, on the Caspian Sea, to the port of Batoum, on the Black Sea, which has been the great shipping point for Russian oil ever since the railroad between the two places has been completed. The concession is made to a company of French and Russian capitalists, who propose to put down a single line of 8-in. pipe between the two points. For about one-half the distance this line will follow the railroad, but its eastern half will be located on a different and more direct line.

The details of the construction of the line and of the pumping stations and machinery required will follow very nearly American practice, the only exception apparently being that some greater precautions than are used here for the protection of the pipe will be required in the wilder and less inhabited parts of the country through which it passes.

The total length of the line will be 497 miles; the highest summit to be overcome is about 1,100 ft., and no serious difficulty is anticipated in the construction or in the operation of the line. Twenty-four pumping stations are provided for by the plans, and such arrangements will be made that the pipe can be duplicated in case of necessity, although it is not expected that a second pipe will be needed for some years to come.

The export of Russian petroleum has been heretofore limited by the fact that the only line by which it can reach European markets has been the railroad line from Baku to Batoum. The capacity of this line is limited by the very high grades which had to be used in carrying it through the Suram Pass, and its charges have been necessarily high. It is anticipated that when the pipe line is in operation the quantity of oil sent can be very largely increased, while at the same time the charges can be considerably reduced. Under these conditions it is thought that Russian oil will become a much more formidable rival to the American product than has been heretofore the case.

It is stated that as soon as the pipe line is open the principal seat of the refining industry will be removed from Baku to the Black Sea end of the line. There are two reasons for this, the first being that the business of refining can be more advantageously conducted there, and the second, that a market can be found for the refuse as fuel for the Russian naval vessels and also for the commercial vessels navigating the Black Sea. This refuse has long been used for fuel on the steamers navigating the Caspian Sea, but their number is comparatively small, and a very large amount of it was practically wasted and thrown away. On the Black Sea, however, the number of steamers is very much greater, and the petroleum refuse can be supplied to them at a price relatively very much lower than coal.

THE question of the organization of a naval reserve is now attracting much attention. It was brought before the United States Naval Institute at a recent meeting in New York, by a long paper by Captain A. P. Cooke, which dealt chiefly with the question of the proper organization of such a reserve, and did not refer to any provision for a reserve of ships. Captain Cooke urged strongly the necessity of organizing and training a naval militia, and sketched a plan for its training. This force would be composed of both officers and men, and would at all times be ready for service in case of an emergency requiring its services.

If the Navy is to be increased, and especially if reserve ships are to be provided, some such organization will be a necessity. Its connection with the active Navy should be as close as possible, as a reserve must depend upon naval officers for its training, and must act with and under their command in time of war. The management of such a force, however, and the proper adjustment of the many questions which must arise in connection with it, will not be an easy matter.

THE dynamite gun, according to the report of the board of naval officers who examined it, has met all the requirements made so far, and has established its claim to a place in warfare. The contract under which this gun was to be furnished to the Navy called for a range of one mile; this was exceeded in the trials made, and it is thought that two miles can be reached. The accuracy of aim is considered remarkable; this is probably due to the fact that the force of compressed air can be regulated and calculated on with much more certainty than that of gunpowder. The naval board consider it a valuable weapon for defence and, in certain cases, for attack. The gun has the further merits that its cost is not great, and that its manufacture is not difficult.

The trials of this gun on the boat which is specially built for this service will be watched with much interest.

SOME remarkable experiments have lately been made with the Graydon projectile, which is a steel shell with a charge of dynamite, and is intended to be fired from an ordinary gun with gunpowder. This shell was tried in 1886 with a 3-in. field-piece and soon after from a 4½-in. siege-gun, near San Francisco. The latest trials, in December, were at Sandy Hook, with a 7-in. gun; the projectile weighed 122 lbs. and carried a charge of 2⅝ lbs. of dynamite.

The destructive effects of the explosion of these projectiles were very great. This was expected, the main purpose of the trials being not to settle this point, but to ascertain the possibility of using shells loaded with high explosives with an ordinary cannon. So far this has been done with the Graydon shell without accidents from premature explosion, but the amount of dynamite is very small in comparison with the weight of the projectile. For heavy charges the pneumatic gun is at present to be the only available weapon. The ordinary gun, however, has the advantage of a greater range, and if it is found to be possible to use a dynamite shell the destructive power of the projectile will be much increased.

THE 111-ton gun just completed for the English Navy, which is illustrated on another page, is probably the most destructive single weapon which has ever been made. Its full capacity will not be known until after the tests, for which preparations are now being made; but there is no doubt that it exceeds in projectile power any gun heretofore manufactured, including the great Armstrong and Krupp guns made for the Italian Government, which have heretofore been the most powerful pieces of artillery in existence.

A question, however, which is still to be tested is whether such a tremendous engine of war will be worth to its owners what it has cost. The difficulties attending the firing of so large a gun are not slight, and even the handling of the projectiles used with it and the arranging for its proper loading require ingenious and complicated machinery, which must be always liable to get out of order at a critical moment. While even on land the difficulties attending proper aiming and firing of such a gun are not inconsiderable, when it is mounted on so unstable a base as even the largest ship must be, they will be greatly increased. Moreover, the expense of firing so large a gun is very great, and when even a single shot is missed in action the loss must be taken into account.

It is, we think, hardly an open question with the best authorities on the subject that the amount of money expended in a gun of this kind could be used to much better advantage in the construction of several smaller and more manageable pieces. The cost of guns, it must be remembered, does not increase in direct ratio to their size, but very much more rapidly, while the difficulty of handling them also increases in almost the same proportion as their cost.

While a gun of this kind must produce great destruction when its projectiles strike where they are intended to, it may almost be regarded rather as a costly toy intended to feed national vanity, than as an actual useful addition to the armory of its owners.

As the penetrating power of a projectile from this gun will probably be greater than that of any yet used, ingenuity will now be applied to the construction of a vessel with armor strong enough to resist its impact.

A TUNNEL under the East River to connect the Long Island system of railroads with the New York Central is proposed. The plan provides for an underground line from Long Island City under the river and under the streets of New York to a point near the Grand Central Station, with an extension running nearly to the Hudson River and thence southward parallel with the river to a

connection with the Hudson River tunnel. For most of the distance across the city the tunnel is to be 50 or 60 ft. below the street level.

The project is not a very promising one as it stands from a financial point of view, although it is probably practicable as an engineering work. The line is too far north to accommodate the great body of the travel between New York and Brooklyn, and it is somewhat doubtful whether it could command business enough to pay interest on the very large amount which the tunnel would cost.

THE Hudson River tunnel continues in a state of suspended animation. No work is in progress at present, and very little was done at the time of the last resumption. Apparently the lack of funds is the only reason for this, as it was stated last year that everything about the work was found in good condition when it was reopened.

MAYOR HEWITT has proposed an addition to the facilities for passenger transportation in New York, to consist of a tunnel or underground line from the Grand Central Station in Forty-second Street to the City Hall. This tunnel, the Mayor suggests, should be built on a line as direct as possible—the one he lays down is partly under the streets and partly under private property—and it should be owned by the city, and leased to a corporation which will operate it under proper restrictions. In connection with the New York Central tracks north of the Grand Central, it will form a new rapid transit line from the Harlem River to the City Hall. As the Central Company already owns a considerable part of this line, and as it is in the best position to utilize the whole of it, the Mayor proposes that that company shall build the new portion and operate the entire line, the city refunding the cost of construction.

Without discussing here the questions of city ownership or of the proposed method of construction, it would seem that the Mayor's plan is defective in several points. The first, and perhaps the least serious, objection to it is that such a trunk line of city travel as he proposes should not end at the City Hall, but should be continued to the Battery. While it is true that an enormous traffic would come to such a line from the Brooklyn Bridge, and that a very large proportion of the passengers do not go south of that point, it is also true that there is a large traffic originating further south, which needs and should have accommodation.

A second objection is, that the existing tracks of the New York Central north of Forty-second Street, while they would serve the purpose for a time, would certainly be overtaxed in a short time if a great volume of city travel were thrown upon them in addition to that which they now carry. In a few years additional tracks would be needed, and it is a question whether it would not be better to build them at once, and on a different line from Fourth Avenue.

The third, and perhaps the most important objection to the plan, is that it does not provide for the West Side, which is the growing section of the city. At present the East Side furnishes the larger volume of traffic, and it would be accommodated by the Mayor's line; but this condition is rapidly changing, and there is no doubt that in a very few years it will be the West Side travel which will preponderate, and must be considered. No plan for new lines can be called complete which does not take this into account.

The Mayor's plan, however, contains some valuable ideas, and is well worth careful consideration. With some expansions, such as have been briefly suggested, it may prove the solution of the problem.

THERE is an opening for railroad contractors in Morocco. The King of Belgium recently sent an Embassy to that country, and chief among the presents sent with it to the Sultan was a locomotive and a passenger car. Now there is not, we believe, in all Morocco a single mile of railroad track of any description, and as the Sultan will undoubtedly want to use his present, the first contractor who gets there will probably have an excellent chance for the job, and will, moreover, not be limited by any inconvenient questions as to prices. The only trouble is that in Morocco the Secretary of the Treasury pays bills when he gets ready—and it generally takes him a very long time to get ready. Moreover, that official is, we believe, clothed with full authority to apply the bastinado and the bowstring to any persistent or troublesome creditor who might presume to disturb his rest with inconvenient or unseasonable demands for payment.

RUSSIAN RAILROADS IN ASIA.

VERY few people appreciate or understand the immense amount of work which the Russians have so far accomplished on their line into Central Asia beyond the Caspian Sea. The telegraph recently informed us that this line had crossed the Amu-Daria River (the ancient Oxus) at Tcharjui, and was pushing rapidly forward toward Samarcand. Now, while most of us have heard of Bokhara and Samarcand, of the Oxus and of other names along the line, they occur to us rather in connection with history and poetry than with actual modern fact and commerce.

To understand the actual railroad progress so far accomplished, we must remember that the Russians now control, in effect, the entire Caspian Sea and the countries which surround it. They have free communication with its waters, both by rail and by the great water highway of the Volga, and their new line starts from its eastern shore at Mikailoffsk. This point is already well advanced to the eastward, being north of and almost on a line with the central portion of Persia.

From Mikailoffsk the road runs east by south, following the foot-hills of the mountain chain which forms the northern boundary of Persia, through Kizil-Arvat to Askabad. Here it makes a long detour to the north to avoid the almost endless swamps in which the Heri-Rud looses itself, and reaches Merv at a distance of about 425 miles from the Caspian. Both strategically and commercially Merv is an important point, and it will be equally important as a railroad town, for there the line will divide into two branches.

The one which is now in progress is completed, as was said above, to Tcharjui, at the crossing of the Oxus, about 170 miles. It is nearly finished to Samarcand, 75 miles still further, and will be pushed on through the 130 miles of very easy work which will carry it to Tashkend. This will be undoubtedly finished before the end of the year, and the terminus will then be 800 miles beyond the Caspian, and within easy reach of the western frontier of the Chinese Empire.

Commercially speaking, this branch of the road will be by far the more important. It follows nearly a very ancient highway of trade, and passes through several towns which have been for ages centers of the commerce carried on by caravan. In a not impossible contingency it may be carried further east and even into China itself—that is, if the mountains of the Central Asiatic plateau do not interpose insurmountable obstacles. It is a little too soon, perhaps, to speculate on such possibilities, but it may be that hereafter this will be a part of the Asiatic transcontinental line which will furnish an outlet to the Chinese system of railroads which will one day exist—though hardly in our generation.

The Russians are not troubling themselves as yet about these future possibilities, and they are most concerned at present about the southern branch of the line. This cannot be built just yet without involving complications which the Government is not ready to assume. It is, however, well understood that all the necessary surveys have been made, and that when the time comes the material will be ready to build the line quickly from Merv due south to Herat, and thence east to Cabul and the frontier of British India. Besides the surveys and the material there is ready a large force of soldiers whose experience has made them trained railroad-builders, and who are well provided with the implements needed for their work.

This line, it must be understood, has been built and is so far operated purely as a military road. Its sole purpose so far has been to consolidate and secure the Russian control in Central Asia, and to prepare the way for further aggression, either in the direction of China or India. In following the military line, however, it has also been necessary to follow the natural line, and there is little doubt that when the present rigorous management is so far relaxed as to permit commerce as well as war to be considered, a traffic of value and importance can be built up. This will take some time, however, and it is not likely that even a beginning will be made until there is a marked change in the policy of the Russian Government. The line is there, however, and some day it will be utilized.

From Merv to Herat and Cabul once built, it would not take long to join the English frontier line. Could the jealousies of the English and Russian governments be settled, a continuous rail overland route to India would be possible within two or three years. Such a thing, however, is not to be hoped for, much less expected.

In addition to this Central Asiatic line, the Russian Government has begun another, which, while less important from a political point of view, has a more directly pacific and commercial purpose. This is the great Siberian line, which is to cross Southern Siberia and find its terminus in the settlements on the Amoor River. While this line, like all undertaken by the Government, is largely controlled by military considerations, it has a definite purpose beyond that, and is meant to develop the resources of Southern Siberia and to aid the commerce now carried on overland with China. There is no doubt that there are considerable possibilities for the line in both directions.

The military necessity for the Siberian line, however, is not considered pressing, and it will advance slowly for some time to come. The purpose is to continue it steadily, however, and it may be only a few years before a continuous line extends from St. Petersburg to the Pacific.

Little Delays.

It is an undeniable and also an unfortunate fact that very few railroad managers seem to realize the trouble and annoyance caused by small delays to passenger trains. Obstructions that will produce serious delay are generally guarded against with care ; when they do happen there is usually some valid excuse for them, and provision is made for forwarding passengers as quickly as possible ; but even on the best-managed lines the delay of ten or fifteen minutes is generally accepted as inevitable, and no special pains seems to be taken to avoid its recurrence.

Now it is just these ten or fifteen minute stoppages that try the patience of passengers and set them grumbling. The man who goes from Philadelphia to New York, for instance, and finds that the train is ten minutes late in leaving the station and that some other little delay arises on the line, so that he reaches his destination just too late to meet an important appointment or to make a connection with another road, is the man who leaves the cars with a feeling that there is something wrong about the management and a determination to try the other line next time. Where competition is active and business closely divided, as it is now on most important lines, this feeling is sure to tell on the receipts ; and in the end it will be the line on which there are the fewest little delays which will secure the best share of the business. Did space permit, some striking illustrations of this could be given without going many miles from New York.

It would be possible to name more than one road on which this carelessness as to small delays extends so far that it is almost impossible for a traveler to be sure of his time of arrival, even on a journey of moderate length. Something of this is, perhaps, due to the rage for fast trains. To secure an advantage over a rival line the schedule is cut down to the lowest possible point, so that there is no opportunity for an engineer to make up the five minutes lost at an open draw-bridge, or even the two or three minutes' detention by an unusual number of passengers at an intermediate station, or a temporary block in a terminal yard. Fast time is all very well, and most passengers like it ; but it is also true that ninety-nine out of one hundred travelers would prefer a train which took ten minutes more schedule time to one hundred miles, if they could rely upon arriving at the appointed time.

It is an old saying that it is the little worries of life that kill a man, not the great misfortunes. This has its application in railroad management as well as elsewhere, and when superintendents once fully realize how much the little delays hurt the reputation and popularity of a railroad, it is safe to say that nine out of ten of those which now occur will be avoided.

NEW PUBLICATIONS.

THE GRAPHICAL STATICS OF MECHANISM: BY PROFESSOR GUSTAV HERMANN. TRANSLATED AND ANNOTATED BY A. P. SMITH, M.E. New York; D. Van Nostrand, 1887. Cloth, 12mo, ix + 158 pages, with 8 plates.

The term statics generally means the science of forces in equilibrium, and has for its object the determination from given applied forces of previously unknown forces,

stresses, shears, or bending moments. The graphical application of statics to beams, roof and bridge trusses, shafts, and other structures has been thoroughly developed, and is recognized as of equal importance with analytical investigations on account of its ease of application and the clearness with which it presents to the eye all the elements of the problem. In this work the graphical method is extended so as to take into account friction and the special hurtful resistances to motion. This is effected by the help of the principle that, when one body begins to move upon another, the direction of the resultant pressure makes an angle with the normal to the plane of contact equal to the angle of friction. The coefficients of friction, known from experiment, are the tangents of the angles of friction, which may hence be constructed for special problems, and from which the forces lost in friction are determined for given data. Since in many cases the applied and frictional forces are proportional to the imparted and lost work, a direct determination of the efficiency of simple mechanisms is effected. These principles, in connection with that of the force polygon, open a new field of graphical analysis in which numerous problems involving friction appear in a clear and simple light, while the analytical solution is often of a difficult nature. The book consists of ten sections or chapters, which treat of the equilibrium and efficiency of mechanisms, of sliding, journal, rolling, chain, and tooth friction, of the stiffness of ropes, and of belting. It is designed as a text-book for technical schools, and also as a guide for the use of machinists and engineers. The plates, although much reduced in size from the original, are in general clear and distinct.

In computing results from formulas there is usually the temptation to carry the numerical work to a far greater degree of refinement than the data of the problem warrant. This is not the case in the graphical method, and the following remark of the author on this point is an important one for consideration by those who use formulæ: "A coefficient of friction is never given with certainty beyond two decimal places, as a glance at the tables of these coefficients shows, and it is safe to assume that in the average case there is an uncertainty of several per cent. In the light of these facts, how worthless is the determination of forces carried out to many decimal places, to hundred-thousandths even, as is the case in many analytical deductions!" This book will undoubtedly tend to give clear, rational views of frictional resistances, and of the work thereby lost in mechanisms, to all who read it with care.

THE ELASTICITY AND RESISTANCE OF THE MATERIALS OF ENGINEERING: BY WILLIAM H. BURR, C.E. SECOND EDITION, REVISED AND ENLARGED. New York; John Wiley & Sons, 1888. Cloth, octavo, xvii + 753 pages.

This book is divided into two parts, first the rational or theoretical, and second the technical or experimental discussion of materials. In the technical part, which is the really valuable portion of the work, embracing over 500 pages, are grouped the data of a large number of experiments, classified and reduced to a form in which they may be conveniently used, with discussions of the laws deduced therefrom, and practical rules and formulas. A comparison with the first edition strikingly illustrates the rapid advance made during the past few years in our experimental knowledge of the properties of materials. The principal changes introduced by the revision are the substitution of later and more precise experiments on wrought iron and steel for some of those previously given, a considerable extension of the discussion of experiments upon columns, and new specimens of specifications for bridge work, showing the practice of leading engineers. Some later experiments and methods are also mentioned in the articles on steel and cement under compression, and in the discussion of riveted joints. The fullness of the matter presented, covering as it does our entire range of knowledge of the elasticity and strength of materials, together with the careful and painstaking manner in which it is arranged and discussed, entitle this book to be called one of the most valuable ever published on this subject.

We observe but one error which calls for public notice. In stating the results of the experiments of Wöhler and Spangenberg upon the fatigue of metals, the stresses per square inch given on pages 709–714 are all about 6 per cent. too large. In these experiments the stresses were measured in centners per Rheinisch square inch, and the author, in reducing them to pounds per English square inch, has evidently regarded the two inches as equivalent, thus making the iron and steel of Germany appear of better quality than was actually the case. No general conclusions regarding the fatigue of metal are, however, influenced by this inadvertence.

The theoretical part of the book will be found to be difficult reading except by those well acquainted with mathematics. In the addendum to Article 24 are given the results for the maximum moments and deflections in beams due to various loads, the span to be taken in feet, and the other dimensions in inches. This mixture of different units seems certainly undesirable in rational formulas, although it is often a convenience in making numerical computations.

The art of stereotyping tends to prevents changes in books, so that often the second edition of a work is a mere reprint of the exact matter of the first edition. In this case, however, there have been made numerous alterations and amendments, while the new matter added gives a valuable record of the many experimental investigations of the past four years.

THERMODYNAMICS: BY DE VOLSON WOOD, C.E., M.A., PROFESSOR OF ENGINEERING IN STEVENS INSTITUTE OF TECHNOLOGY. New York; Burr Printing House, 1887.

This is a work in small octavo, embracing 234 pages, which is especially designed for the course of instruction given by the author, who states that no attempt has been made to adapt it to the wants of others. The experience and success of Professor Wood as a teacher, author, and investigator is, however, so well known, that a book from his pen is sure to command the attention and careful examination of those who teach the subject in technical schools, especially since few works treat it in a manner both comprehensive and clear. The book resembles in plan and arrangement the works of the author on mechanics, and contains a large number of practical examples and problems which cannot but be highly advantageous to students. It may, indeed, be asserted that the solution of numerical exercises is an absolute necessity for the correct understanding of thermodynamics.

The first chapter treats of the general principles relating to heat, temperature, and work, explaining Carnot's cycle,

the experimental determinations of the mechanical equivalent of heat, and the thermodynamic laws. The second chapter discusses perfect gases and the work performed by their expansion under different conditions, while the third treats of imperfect gases, of which the most important is steam, in full detail. Chapter fourth gives the thermodynamics of heat engines, where among other problems is presented the interesting one of the determination of the most economical point of cut-off. In an appendix a recent paper by the author on the luminiferous ether is reprinted.

In describing the thermometer it is incidentally stated that it is possible to reduce the temperature of water several degrees below 32° Fahrenheit before freezing, and that "to secure such a result the water must be kept in a condition of as perfect rest as possible." This fact, if such it be, is new to us. The lowering of the freezing point by pressure is well known, but the general opinion is that water under the ordinary atmospheric pressure cannot be reduced in temperature below the freezing point, except when in a condition of constant agitation.

The author defines Thermodynamics to be "the science which treats of the mechanical theory of heat." This book seems better adapted for the use of students of this important science than any other with which we are acquainted.

A TEXT-BOOK OF INORGANIC CHEMISTRY: BY PROFESSOR VICTOR VON RICHTER, TRANSLATED BY PROFESSOR EDGAR F. SMITH. Philadelphia; P. Blakiston, Son & Co.

The high reputation of Professor Richter, and the success attending his methods of teaching, have given his text-books a large circulation, both in England and in this country. One of the leading features of his method, in which he differs from most of the older text-books, is the care taken to present theories and facts together, and to show their proper relations. Another special feature of the book is the prominence given to thermo-chemical phenomena and to the law of the periodicity of the elements as affirmed by Mendelejeff, and now widely accepted.

The present is the third American, translated from the fifth German edition, which contains several additions, bringing the work up to the point of the latest discoveries and investigations.

BOOKS RECEIVED.

SCRIBNER'S MAGAZINE for March will contain a paper on "Electric Motors" by Mr. F. J. Pope, who is a high authority on electrical matters. This magazine, it is announced, has in preparation a series of articles on railroad construction and operation, written by experts in the various departments and fully illustrated. Such a series will doubtless be of much interest to railroad men, and also to the public, in whose daily life and business the railroad plays so important a part.

GENERAL SPECIFICATIONS FOR HIGHWAY BRIDGES OF IRON AND STEEL: BY J. A. L. WADDELL, CONSULTING ENGINEER. Kansas City, Mo.; Macdonald & Spencer.

THE NATIONAL SIN OF LITERARY PIRACY: BY HENRY VAN DYKE, D.D. New York; Charles Scribner's Sons. This is a reprint of a sermon by Rev. Dr. Van Dyke, of New York, which is intended to set forth the moral view of the international copyright question, which is just now under active discussion.

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present installment of these occasional papers includes Sizing Paper with Rosin, by James William Wyatt; Southampton Sewage Clarification and House Refuse Disposal Works, by William B. G. Bennett; Tachometry; or, Rapid Surveying, by Bennett Hooper Brough; Propelling Machinery of Modern Warships, by Sidney Herbert Wells—a paper of much interest and value; and the usual Abstract of papers in foreign transactions and periodicals.

A PEOPLE'S UNIVERSITY: ADDRESS BEFORE CORNELL UNIVERSITY ON FOUNDER'S DAY, 1888: BY J. G. SCHURMAN, PROFESSOR OF PHILOSOPHY. Ithaca, N. Y.; published by the University.

SCHENECTADY LOCOMOTIVE WORKS: CATALOGUE. The new catalogue of these well-known works contains a brief history of the Works; some notes on recent improvements in locomotive construction; general specifications for locomotives as built at the Works, and a large number of photographs of engines of different classes, with descriptions. Perhaps the most notable feature of this catalogue is the great increase in size and weight of the locomotives illustrated over those to be found in similar catalogues published only a few years ago.

A WARNING FROM THE EDISON ELECTRIC LIGHT COMPANY. New York; issued by the Company. This pamphlet contains a statement of the patent claims held by the Edison Company, and of the infringements which, it charges, other companies have made. It presents, of course, only one side of the controversy.

THE HARRIS-CORLISS ENGINE: CATALOGUE. Providence, R. I.; issued by the William A. Harris Steam Engine Company.

Contributions.

Lighting Railroad Cars.

To the Editor of the Railroad and Engineering Journal:

Now that coal can no longer be used for heating railroad cars, it is evident that the use of mineral oils for lighting them will not be long permitted, in which case either gas or electricity must be used for that purpose. How far, therefore, each of these agents can be used to advantage becomes a question of grave importance, and especially if experience should prove that gas will give the best results, as most, if not all, the active interest now taken in the subject by our railroad companies is confined to the use of electricity. Why is that? There is no question that gas as now made for all large cities should be cheaper than electricity for lighting railroad cars, and is certainly more convenient. Why, then, is it not preferred to it for that use? There is a reason, of course, as railroad companies never make expensive experiments merely for the advancement of science; but what it is no one of them, so far as we know, has ever publicly stated. We are therefore left to conjecture until they choose to speak.

Meanwhile, to provide for their not choosing to commit themselves in that way, I ask their attention to the following facts, as I think they give the reason I have referred to, and prove that it is simply prejudice.

It is true that when city gas was only made from coal, and its lighting power was not more than 14 to 16 candles,

it could not be practically used for lighting railroad cars, because (1) to store in their tanks enough of so thin a gas to make its use practical would not only require more storage room than could be conveniently given for that purpose, but the compression necessary for the operation would reduce its light at least one-third ; (2) because the burners used at that time, when compared with those used now, wasted at least one-third of the light-giving power of the gas passing through them ; and (3) because said gas as then furnished by city companies was not only from one-third to one-half poorer than the gas now furnished by them, but its cost per 1,000 ft. was from one-third to one-half more. And therefore it has not been so used, there being no practical evidence that it can be (except in the one case hereinafter referred to), and because of the natural inference from the facts above given that to make gas practical for railroad use it must be made from oil, requiring the erection of special works for making it, and much cost and trouble in their operation, as when that kind of gas is made in quantity too small to warrant costly management, no care can prevent constant clogging of retorts and pipes by carbon deposits ; and it is doubtless as much on that account as from the prejudice above described that companies like the Boston & Albany are now testing electricity for lighting their cars at great cost, although they must know all about gas when used for that purpose, as it has been now for a long time by the Erie, the West Shore, and other companies.

And upon the premises above assumed they are right. But if those premises no longer apply to the question in issue—to wit, whether gas, as now made by city gas companies, or electricity can be best used for lighting railroad cars, taking into the account that when gas is used for lighting them it can also be so conveniently used, in combination with steam from the engine, for heating them. What then ? Let us inquire, using for the illustration, so far as gas is concerned, the use made of it by the Pennsylvania Railroad Company, and so far as electricity is concerned, the use hitherto made of it by the Boston & Albany Railroad Company, in both cases for lighting their cars.

The Pennsylvania Railroad Company to my personal knowledge now lights its cars with gas supplied by the Hoboken Gas-Light Company, having sufficient lighting power to permit easy reading in any part of them, and yet the gas is used under 200 lbs. pressure (when first stored, of course) and at the following cost per car lighted for 10 hours, average light—to wit :

Amount of gas used 400 ft., viz., 6 argand burners consuming about 6 ft. per hour each, at $1.60 per 1,000 ft. (the retail price at Hoboken)....	64.00 cents.
Interest one day on $200, the estimated cost of the storage tanks, regulator, etc., used for one car	2.75 "
Labor, pumping and repairs of apparatus used on one car per one day, say................	3.00 "
Total cost........................	69.75 cents.

That is, as gas is now used by said company ; when it is also used by it for heat, there is no reason why it should cost more than $1.25 per 1,000 ft., in which case its cost for light would be only 55.75 cents, and less yet when we take into account the improvements recently made in regenerative burners, as for the same amount of light they require so much less gas than is required for the burners used at the present time.

Now, in contrast with this showing, what has been done in the use of electricity ? The Boston & Albany Railroad Company has been for many months and still is engaged in testing it for lighting cars. It is, therefore, fair to assume that the results obtained are the best possible, as no company has a better reputation for a wise and economical management. And what are those results ? As we have been reliably informed, they are an addition of 1,800 lbs. to the weight of the car lighted, and an average cost for its light for one night of $2.63. Whether the figures include interest and repairs we have not learned, but assuming they do, is it not money thrown away to experiment with electricity when gas can be used, as there is no reasonable doubt it can be, at not exceeding one-fourth to one-third of its cost ? H. Q. HAWLEY.

The Weight of Rolling Stock and the Wear of Rails.

To the Editor of the Railroad and Engineering Journal :

IN a recent article in the RAILROAD AND ENGINEERING JOURNAL (page 51, February number) upon Locomotives of the Future you refer to the increased weight of locomotives during the last 30 years as being somewhat like an increase from 10,000 lbs. to 17,000 lbs. upon each driver.

Many years ago, before the days of steel rails, it was stated that English locomotives, which up to that time were mostly made with a single pair of drivers, had been made so heavy as to produce a very rapid destruction of the rails, and that when the weight on each wheel reached six gross tons the metal of the rails *flowed* under the weight.

For several years past, in yards where much switching has been done, the flow of the metal of *steel* rails has been very easily seen. At Milwaukee, where a four-wheel switch engine was passing very frequently over a part of a certain track, but rarely going beyond the point where it could reach the end of a long passenger train, it was very evident that the switch engine would have been more properly denominated a rolling mill than a locomotive, as the rails were being *rolled out* rather than *worn out*, while the rails used only by passenger cars underwent normal wear.

The weight of this rail-crusher was said to be 35 tons (=70,000 lbs.), which corresponds nearly to your statement of 17,000 lbs. upon each driver. Similar phenomena can be seen any day in almost any of the large yards in the Northwest.

This indication of excessive weight on drivers has not attracted the attention it deserves. Our enterprising and progressive presidents and managers have gone on ordering heavier and still heavier locomotives and cars, apparently not dreaming that there can be any excess of wheel weight which cannot be met by an increased weight of rail. It is quite certain that they rarely consult an engineer about it, much less ask him to give the subject a special study.

In a few instances I have endeavored to ascertain by observation the real average bearing area of a wheel upon a rail, but as it required one to get in the uncomfortable position of having his head very near the ground, my observations were not very numerous, yet sufficiently so to satisfy me that the area of contact was surprisingly small. The idea suggests itself that some useful information could be obtained by placing a thin sheet of paper upon the rail and observing the width of the track made thereon by a driving-wheel passing over it.

It will probably be found that the area of wheel contact bears little relation to the weight of the rails, that the tires are not uniformly in good form, that *all* rails do not present the same form of surface nor the same rail at different periods.

If a driver 60 in. diameter secures contact 0.84 in. along the rail there must be an elastic yielding of 0.0012 in. at the center of the bearing. Such a contact may be equivalent to $\frac{2}{3}\times 0.84=0.56$ in. by a width varying from say $\frac{1}{2}$ in. to $1\frac{1}{2}$ in. Hence the effective area of contact may vary from 0.28 in. to 0.84 in., producing with 17,000 lbs. upon a driver, over 60,000 lbs. maximum pressure per square inch. This being much beyond the elastic limit of ordinary steel, it easily accounts for the lip so often seen on the heads of the rails.

A simple calculation will also show that a 33-in. wheel carrying 9,350 lbs. will produce the same maximum pressure and a like destructive effect as the 60-in. wheel with the larger load above stated. A chilled wheel, being less elastic, would be even more destructive. A car weighing 25,000 lbs. and carrying 50,000 lbs. load has a weight of 9,375 lbs. upon each wheel. This fact may do something toward accounting for the short life of steel rails at the present time. J. T. DODGE.

Duluth, Minn.

THE MEXICAN IRON MOUNTAIN.

To the Editor of the Railroad and Engineering Journal:

WHILE the existence of a large body of iron ore at this place has been known to many, the magnitude of the deposit is only appreciated by those who have seen it, or by a limited number who have read the reports of a few experts who have visited it professionally.

The most complete account of it was made by Mr. John M. Birkinbine, of Philadelphia, who, I think, examined it in the interest of the Mexican Iron Mountain Manufacturing Company, of Des Moines, Ia., its present owners.

The Iron Mountain, or, as it is called in Mexico, the "Cerro-de-Mercado," is situated a trifle under two miles from the city of Durango, the capital of the State of the same name. It rises from a level plain in a series of mostly vertical cliffs of a columnar structure, though somewhat eased off where it joins the plain by the ore that has fallen from above. On the northwest end or side the ore is in small pieces about right to go into a blast furnace; while on the south side much of the fallen ore is of the same size, still the talus contains more large boulders.

The peaks rise several hundred feet above the plain, one being 700 ft., on which some venturesome person has placed a large cross. The table land of this mass of ore is all of 550 ft. high. The body of ore may be taken as one mile long, one-third of a mile wide, and from 400 to 700 ft. high. It appears to be cut by a dyke of lava, or to have a band of that rock capping a narrow belt of the surface, running nearly east and west. All, or nearly all, the country rock of this part of Mexico, and even clear up into New Mexico, is of this same volcanic rock, in color from white to a light red, very soft at first, but hardening quite perceptibly upon exposure. It is much used for window trimmings and arches of the best houses, and also for rough masonry. If it was within reach of large building centers of the United States it would be a very valuable rock.

In relation to the *kind* of ore here, many mistakes have been made, even by Humboldt and others, it being classed by them as magnetic, while it is doubtful if even a single ounce of that variety exists in the whole deposit. They were probably misled by its crystallization, which is in the form often exhibited by magnetite—octahedrous. However, it is not magnetic; it has no influence on the dipping needle; it is not attracted by a magnet, and its streak is red. It is very properly classed as specular by Mr. Birkinbine.

Chemically it shows from 50 to 68 per cent. of iron, mostly above 60 per cent., low in sulphur, and from a *trace* of phosphorus up to $\frac{6}{10}$ of one per cent. (0.6).

The whole mass of the ore bears evidence of having been in a state of fusion, the pieces of ore being often full of cavities, as if a more fusible mineral had been melted out. Again, in some places large boulders of more than a cubic yard in volume have every appearance of being solid lumps of pure ore, but are found to be only blocks of lava with a superficial skin of iron ore, as if they had been *boiled* in melted iron oxide. It is probable that the whole mass was once magnetite, and now changed to hematite by the agency of heat. The surface of the ore is often covered with perfect crystals, which are not detachable from the mass.

The works of the Mexican Iron Mountain Manufacturing Company are located at the western end of the mountain, distant from it 500 to 800 ft., though 68 per cent. ore is shoveled up within 200 ft. of the stack, and from that point to the mountain or bluff of solid ore is a collection of loose pieces of at least 100 ft. in thickness where it joins, taken on a level with the stock-house floor; how much deeper it extends is not known, further than that ore was found at a depth of 60 ft., when digging a well about as far from the mountain as the stack stands.

The plant consists of a charcoal blast furnace 54×10 ft., with a 40-pipe iron hot blast of 2,000 ft. surface, a Weimer blowing engine, tubular boilers, Crane Brothers' hoist, and Knowles's tank and feed pumps.

A rolling-mill is well along, containing a 10-in. merchant train, a 22-in., and another heavy train, four puddling furnaces, one 450 H.P. Porter-Hamilton engine, and 2 Heine boilers. A machine shop, foundry, pattern shop, etc., are now in operation, doing the company's work and such outside business as they can without interference with repairs and construction now going on.

The furnace is now being relined, and will go in blast as soon as finished, say in three months, after which a steel plant will probably be added.

Fuel is found in the cañons and along the base of the foot-hills, as well as on the table lands, in sufficient quantities to be pronounced inexhaustible—oak, pine, huisache, and mezquite—yielding charcoal weighing 25 lbs. per bushel.

Limestone of rather poor quality is found within a mile of the furnace. As the ore is very rich, a poor quality of stone will do fully as well.

Good clay for making fire-bricks is yet to be found; a good sandstone, containing 95 per cent. of silica, is found about $1\frac{1}{2}$ miles from the furnace.

The climate of this part of Mexico is all that could be desired, in winter varying from the freezing point up to 70°, and in summer never going above 86°, the elevation, 6,700 ft., accounting for the trifling variation. Middle-aged people who have always lived in Durango saw snow for the first time this winter. N.

Durango, Mexico.

THE PRINCIPLES OF RAILROAD LOCATION.

BY PROFESSOR C. D. JAMESON.

(*Continued from page* 63.)

CHAPTER XII.

THE LEVEL PARTY.

THE LEVEL PARTY, as has been said, consists of the leveler and his rodman, and the object of their work is to get the actual height of each station above some known plane, in order to plot the profile of the line and to "establish the grade line."

The leveler must proceed with his work a certain distance behind the transit party—never more than one day and not less than half a day.

The first thing to be done by the leveler in starting any new line is to get some point to start from. When the new work connects with some old-established line, then the leveler should start from some point on this old line, the height of which he can obtain. But if there is no permanent point, the height of which is known, then the leveler must establish some point and get its height above the sea-level as exactly as possible with the aneroid barometer; then proceed with his work, using the height thus obtained.

This permanent point is called a BENCH MARK, and is marked "B. M." Not only is this starting-point called a bench mark, but all permanent points which the leveler may establish along the line for future reference are called bench marks. They are marked and located as follows:

In the note-book there must be a full and clear description of each one of these bench marks in that part of the book where the B. Ms. occur in the regular line of the notes. It is a good plan also to leave a few pages blank in the back of the level-book, and on these pages copy all the B. Ms. in their order, with the number, description, and elevation of each. In getting a B. M. in the field the object is to get some firm point which cannot be moved, and is so situated that it may be readily found again. In running through a wooded country the most common method of making a B. M. is to take some large prominent tree and chop a place on the root, as shown in Plate XXII, fig. 7, and drive a tack in the top of the point. Then the point and all around it should be marked over with keel. On the side of the tree at a convenient height to be readily seen, and on the side next to the line a large "blaze" should be made, and on this blaze should be marked clearly with keel the letters B. M., the number of the B. M., and its elevation, as shown.

The objection to using the point of a ledge of rock, etc., is the difficulty of so marking and distinguishing the point used that it can readily be found again. In running through towns or cities, bench marks can be established on the corners of foundation walls, copings, etc. Care should always be taken to have the number and elevation of each bench mark clearly marked near it.

In running a line of levels on preliminary surveys, B. Ms. should always be established as often as every 2,000 ft. This distance apart of the B. Ms. depends, of course, to a great extent upon the nature of the country.

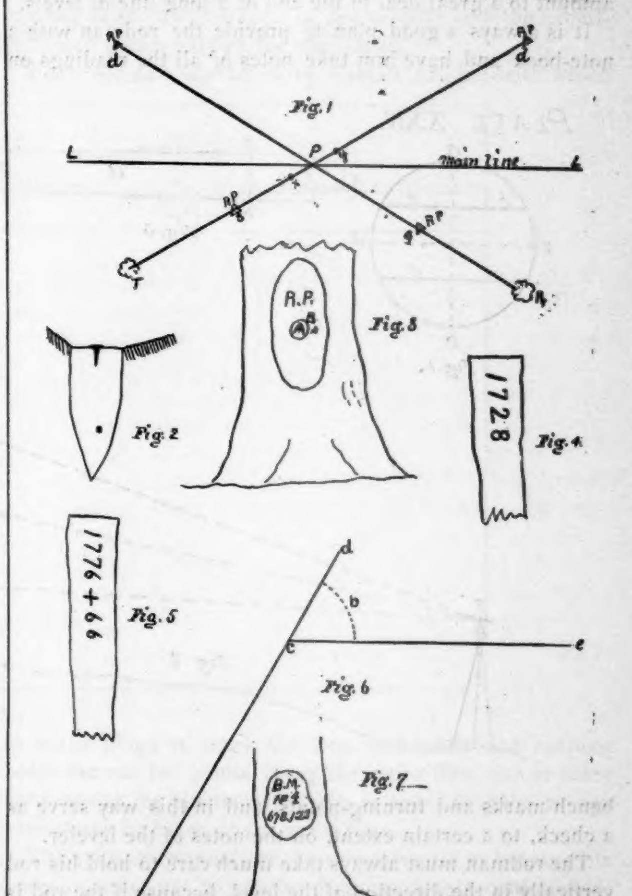
The leveler proceeds with his work as follows: Having a starting-point, or B. M., he sets up his level at a proper distance from it and levels its telescope. The rod is held on the B. M. and the telescope sighted on it, and the point on the rod where it is cut by the horizontal hair of the telescope is noted in the note-book.

This is called a plus (+) or back-sight. Now the distance from the bottom of the rod or the B. M. to the point where the rod is cut by the horizontal hair, is the distance that the center of the telescope is above the B. M., and this distance or reading on the rod added to the elevation of the B. M. gives the height of the instrument.

Having the height of the instrument, sights may be taken on the different stations. These are the minus (—), or fore-sights, and by subtracting the fore-sight of each station from the instrument height will give the height or elevation of each station.

When as many stations as possible have been taken from one position of the instrument, and it is desired to move

PLATE XXII



it ahead, the rodman is notified of the fact, and he at once takes a "turning-point." This turning-point is merely a firm point, which may be a bench mark, a station, or a special point. As it is only to be used once, there is no need of locating or describing it in any way in the note-book, beyond the fact that such a reading on the rod is a plus (+) reading or a minus (—) reading on a turning-point.

When the rodman has the rod on the turning-point the leveler obtains the elevation of it the same as one of the stations. He then moves ahead or to any convenient position and sets up his level and obtains the height of his instrument by taking a reading on the rod, still held on the

turning-point, and adding this reading to the elevation of the turning-point. The rodman must use the greatest care that the rod is held in exactly the same place for the plus as for the minus sight.

In all leveling the leveler should read his own rod through the telescope. When taking the height of stations these readings need only be taken to the nearest hundredth of a foot. But on bench marks and turning-points the readings must be taken to the thousandth of a foot, and the target and vernier scale should be used. The reason of using so much more care on turning-points than upon stations is this: Any error made in taking the elevation of a station is not carried beyond that station, and if it is of any amount can be detected at once when the profile is made, while any error made in either the plus or minus readings or the elevation of a turning-point is carried on in every elevation that is afterward taken, and if much care is not taken the sum of a number of these errors will amount to a great deal in the end of a long line of levels.

It is always a good plan to provide the rodman with a note-book and have him take notes of all the readings on bench marks and turning-points, and in this way serve as a check, to a certain extent, on the notes of the leveler.

The rodman must always take much care to hold his rod vertically in the direction of the level, because if the rod is inclined either toward or away from the level, the reading taken will be too great.

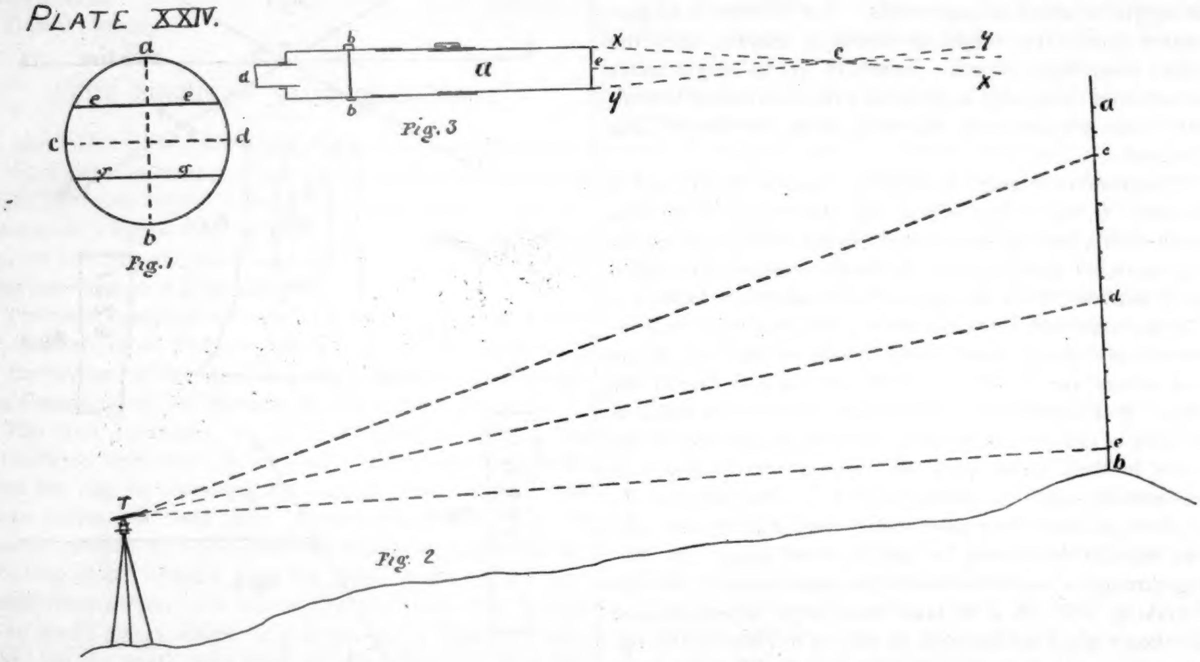
A good plan on turning-points and on other points where much accuracy is needed is to have the rodman slowly swing the rod toward and from the level, moving the upper end while keeping the lower end on the required point. The leveler will then take for his reading the lowest point on the rod cut by the horizontal hair, as this will be the point when the rod is vertical. There is also a disk level made, which the rodman holds in his hand against the side of the rod, and by means of which the rod can be held perfectly vertical. In holding the rod the rodman must take care not to cover the face of the rod with his fingers, but should always hold the rod in both hands and keep his fingers on the sides of the rod.

When time will permit, the line of levels should be checked by the work being gone over a second time and the elevations simply of the bench marks taken.

In the field the leveler should always work out his turning-points and as much else as possible. When the party returns to camp at night the leveler should work up all his notes, and make the profile of the line he has gone over during the day. When this has been done the Chief of Party carefully examines it as regards grade and the amount of work to be done in construction. In keeping the level notes one or two lines should be left blank at the bottom of each page, so that always before the leveler turns a page he may add his plus sights and his minus sights, and obtain the difference between the sums, which will give him the difference in elevation between the points at the top and bottom of the page.

By the sum of the minus sights we mean simply the minus sights on the turning-points and not on each station. By this means the leveler checks his work as far as the working out of his elevations goes, on each page.

PLATE XXIV.



CHAPTER XIII.

STADIA SURVEYING.

With regard to what follows upon the use of the STADIA, let us say that we have only applied it to railroad surveying, and in its most elementary form. The first requisite is an explanation of what the stadia is.

In the telescope of any transit there are, as we have shown, two hairs or very fine platinum wires which cross each other at right angles, one of them being vertical and the other horizontal, as shown in Plate XXIV, fig. 1, which represents the end of a telescope. The two lines *a b* and *c d* represent the cross-hairs, and *e e* and *g g* represent the stadia wires. These are two horizontal wires placed one above and one below the horizontal cross-hair, and at equal distances from it.

If these stadia wires are so arranged that they can be moved and thus set at any required distance from the cross-hair *c d*, it is called a "movable stadia," and when the wires cannot be so moved, a "fixed stadia."

The object of these two wires is as follows: If we look through the telescope at a "stadia rod" (Plate XXIV, fig. 2), which is held the same as a level rod, we will see that a certain distance on the rod is intercepted between the stadia wires. If the rod is brought nearer the telescope, this intercepted distance on the rod becomes less, and as the rod is removed from the telescope the intercepted space becomes greater.

In Plate XXIV, fig. 3, let the lines *x x* and *y y* represent the lines of sight as bounded by the stadia wires; it will be seen that these two lines cross each other at *c*, after which they continue to diverge. The distance from the object-glass *e* to the point *c* is called the focal distance of the telescope, and is always equal to the distance from *e* to the stadia wires *b b*.

If a stadia rod be held at *c* there will be no space intercepted by the wires. Now move the rod any distance, say 100 ft., from *c*, and have it carefully held there. Then set the wires so that they shall intercept exactly 1 ft. on the rod; we can then measure the distance of the rod from the instrument up to 1,000 ft. with a rod 10 ft. long, and a greater distance with a longer rod. Thus if, when the rod is 100 ft. from *c* the wires intercept 1 ft., then with the rod at 200 ft. from *c* the wires will intercept 2 ft., and when the wires intercept 7.5 ft. on the rod, it will be just 750 ft. from *c*, and so on. The transit gives the direction of each of these lines, either by means of direct measurement of the angles, or by the magnetic needle. We can thus see how, without actually measuring on the ground, both the length and direction of any line on the ground may be obtained by means of the stadia.

So far we have considered the ground level and the telescope of the transit horizontal, thus making the rod vertical and at right angles to the center line of the telescope. This, however, is very seldom the case.

To take the distance of the rod from the transit directly from the distance on the rod intercepted by the stadia wires, the rod must always be at right angles to the center line of the telescope. In running through a rough country this would often be impossible, and it is necessary to measure the vertical angle of depression or elevation, as the point on which the rod is held is higher or lower than the point over which the transit is set up. In order to obtain the elevation of these points, tables have been prepared from which the actual horizontal and vertical distances of any point can be taken when the vertical angle and the distance on the rod between the stadia wires are known, the rod in every case being held vertical.

The vertical angle and the reading on the rod do not give directly either the elevation of the point where the rod is held or its horizontal distance from the transit, for the reason that the rod is held vertically and not at right angles with the center line of the telescope. But by means of these two readings we can take both the horizontal distance and elevation of the point from prepared tables.

From the foregoing explanation one can fully understand the many advantages possessed by the stadia method over the transit and level on preliminary work. One man does the work of two with the instruments (transitman and leveler), and the number of rodmen he can use and the rapidity with which he can get over the ground depends entirely upon the character of the country and the experience and personality of the stadiaman.

Each rodman should carry a small hatchet with which to make plugs to mark the line, and while one rodman holds the rod for points along the main line, one or more rodmen can be out on each side in order that the topography may be taken at the same time.

Stadia – Preliminary. Notes.

Object.	Azimuth	Distance	Vertical Angle.	Difference of Elevation	Elevation above datum	Remarks.
Height of Inst.						
Elevation ⊡						

PLATE XXV.

The stadiaman must use the greatest care in keeping his notes in order not to get the different points confounded. Plate XXV is a sample page of a blank for the field notes of a stadia survey.

In the transit to be used for stadia work the following features are necessary to insure accurate work: The horizontal circle should be graduated from 0 to 360° in the direction of the hands of a watch, as then the azimuths of the different lines can be read in one direction. By the azimuth is meant the angle of the line with the true north-and-south line.

There should be an arc of the vertical circle rigidly attached to the telescope, as so much depends upon the vertical angles. The telescope should be inverting. The stadia wires should be fixed. The horizontal circle should read to 30 seconds.

Every instrument should have a solar attachment. The best solar attachment is made by Fauth & Co., Washington.

This can be screwed on to any transit, and is by far the most simple and the least liable to get out of order. The object of this solar attachment is to obtain quickly the true meridian. The only thing necessary to know is the declination of the sun. With a table showing this, one solar observation without any calculation will give the true meridian.

In many cases this can be obtained with accuracy by the needle, knowing the declination of the needle. But in some localities this is impossible, owing to local deposits, which render the needle unreliable.

The manner of making a preliminary survey with the stadia is as follows: The transit is set up over the starting-point and leveled. The vernier is brought to zero on the horizontal circle. Then set the instrument so that the telescope points N. and S. Unclamp the top plate and the instrument is ready for work. With the stadia rod take the height of the instrument—that is, the height above the ground of the center of the telescope. Then send the rodman to the next point to be taken on the main line, and have him drive a plug there. He then holds his rod on this plug with the edge toward the transit, and the transitman, turning only the top part of the instrument, sights on this rod and clamps the two plates together. Then, reading the angle on the horizontal plates, he has the azimuth of the line or the angle which that line makes with a N. and S. line.

The rod is then turned face to the transit, and the telescope is raised and lowered until the central horizontal cross-hair cuts it at the point of the height of the instrument. Then the reading is taken of the distance on the rod that is included between the stadia hairs, and the vertical angle, as denoted by the vertical circle, is read.

These are all noted in the note-book. We then have the three dimensions of the new point that are required.

1. Its direction from the preceding point by means of its azimuth.

2. Its distance from the preceding point by means of the distance intercepted on the rod by the stadia wires.

3. The relative elevation of the point as compared with the preceding point by means of the vertical angle.

The distance and elevation are not taken directly from the reading of the rod and the vertical angle, but must be deduced from these readings by means of properly constructed diagrams or tables.

The best diagram is the one that comes with "Topographical Surveying," by J. B. Johnson, published by John Wiley & Sons, and the best tables for the reductions of stadia readings are in the same book.

After the next point in the center line has been located, then sights are taken on each side to all the points which are required, such as houses, line fences, rivers, streams, and sufficient readings taken on the ground to locate the contour lines. Everything can be taken that is necessary to have on the map of the country in order to make a paper location. The rodmen hold the rods on all these points, but no plugs need be put in. Each point upon which a reading is taken must be fully described in the notes, so that there shall be no mistake. When readings have been taken on all the desired points from one station or point, the transit is moved on to the succeeding one and set up the same as before, and the height of the instrument taken. Then the telescope is sighted back on to the last point, and the vertical angle and the azimuth of that line taken. This serves as a check on the work of the center line. Then another point is put in ahead, and the work proceeds as before.

CHAPTER XIV.

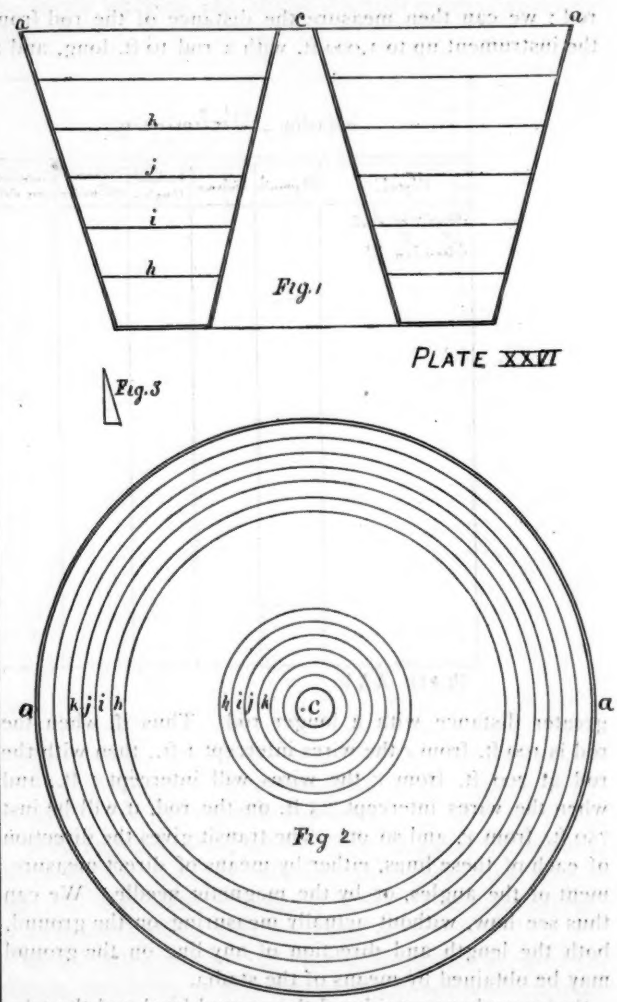
TOPOGRAPHY.

Before explaining the work of the TOPOGRAPHER, it will be necessary to explain and illustrate what is meant by "contour lines" and "contour maps," as it is the data from which these are made which the topographer obtains in the field.

To illustrate what contour lines are, Plate XXVI is given. In this plate let fig. 1 represent a section of a tin dish for baking cakes; *a a* are the sides of the dish, and *c* the tube which comes up through the center.

In fig. 2 the heavy lines represent a plan of the dish, the parts in the two figures being lettered alike.

We set the dish bottom down on a table, and pour in water until it is an inch deep in the dish; then with some



sharp-pointed instrument like a needle we mark around the inside of the dish just at the water-line *h*, also on the center tube. Then again pour in water until it is an inch deeper, and mark this water-line the same as before.

In a like manner continue increasing the depth of the water inch by inch and marking the water-line each time, until the top of the dish is reached. Then turn all the water out, and we have the lines *h, i, j, k*, etc., marked on the dish. Each of these lines is horizontal throughout, and therefore any two of them are the same distance apart vertically.

These lines are "contour lines"—that is, they are level lines following the side of the dish.

Now, to make a "contour map" or plan of this dish we have only to project the lines *h*, *i*, *j*, *k*, etc., upon the plan

On railroad work, where the amount of ground surveyed is comparatively small and a very close representation of the surface of the ground is required, the contours are put in every 10 or 20 ft. apart vertically.

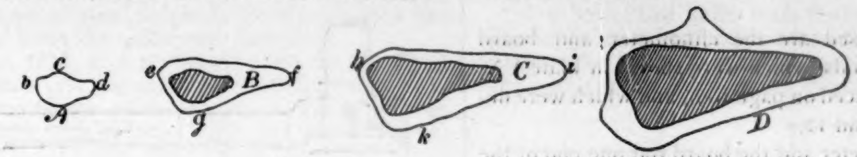
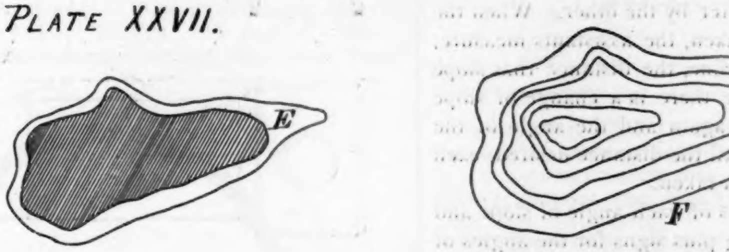


PLATE XXVII.



of the dish, fig. 2, where they are shown by the lighter lines, and thus make fig. 2 a contour map of the dish—that is, it is a plan of the dish so finished that every vertical change in its surface is shown, such as the slope of the sides and the center tube, by means of the contour lines. To get the slope of the side of the dish from the contour map, Plate XXVI, fig. 2, we know that vertically these contours are one inch apart, which distance can be taken as a perpendicular of a right-angled triangle, and the distance *h i*, fig. 2, as the base of the triangle, fig. 3; then the hypothenuse will represent the length and inclination of the side of the dish between any two contours.

Now, as far as the dish is concerned, which has been used as an illustration, it is clear what is meant by contour lines and contour maps.

Now, in the place of the dish, let us take a valley *A*, Plate XXVII, surrounded by land. We will suppose that this valley has water in it 10 ft. deep in the center, and that the lake thus formed would take the shape *b c d*. The water-line on the shore of this lake would be a contour line. Now, imagine the water to rise 10 ft., and we would have a lake of the form *B*, and *e f g* would be a contour line.

Let the water rise again 10 ft., and we have the lake *C* and the contour line *h i k*, and so on. As the water rises we get larger lakes and different shaped contour lines.

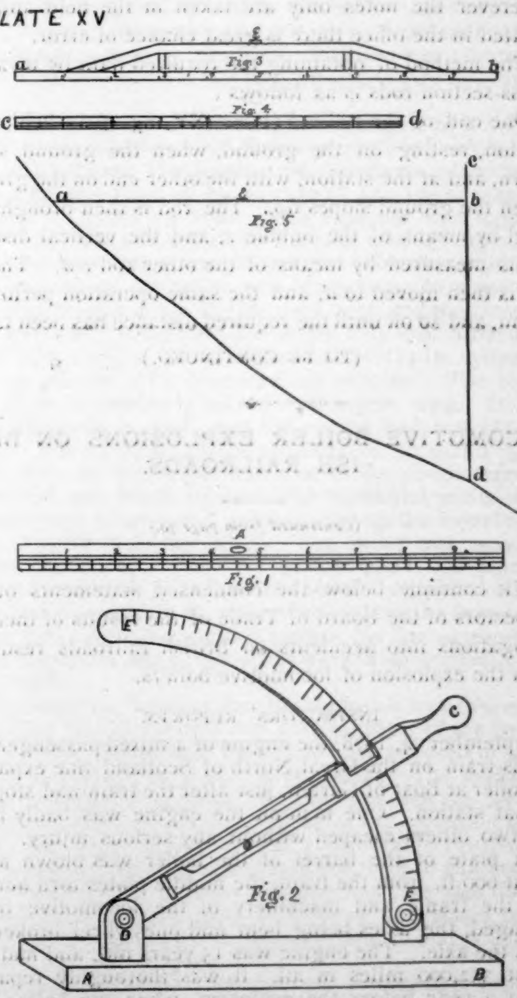
All of these lines that are marked by the water's edge must be contour lines, as the surface of still water is always horizontal, and by plotting these lines one on top of the other in their relative horizontal position, we have the contour map of the valley *F*. *Therefore a contour line is a broken or curved line following the surface of the ground, every point of which is in the same horizontal plane.*

When these lines are plotted on the map of the country in their proper positions we have a contour map, and by means of this map can understand exactly every change in the surface of the ground. The vertical distance between the contours will depend upon the character of the country and the scale upon which the work is done.

In Government work, where thousands of square miles are surveyed and the maps plotted to a very small scale, the contours are often 100 or 200 ft. apart vertically.

Having now fully explained what contour lines and maps are, we will return to the duties of the topographer. These duties are to procure in the field such data that when the line run by the transitman has been plotted, he

PLATE XV



can put in the contour lines and all the prominent topographical features for the required distance on each side of this line.

When, owing to the character of the country, the contour lines are required for only a comparatively short distance of from 100 to 200 ft. on each side of the transit line, the data required are taken by the topographer in the following manner:

The instruments used are the clinometer and board rod, or cross-section rods, which were shown in Plate VX, fig. 1 (which is reproduced on page 109), and which were described on pages 11 and 12.

In using the clinometer and the board rod one end of the rod is placed on the ground at a station and as nearly at right angles with the main line as can be judged quickly by the eye. The clinometer is then placed on the rod and the angle of slope measured. The rod is held by one of the assistants and the clinometer by the other. When the angle of the slope has been taken, the assistants measure, with either the rod or a tape-line, the distance that slope continues. At a point where there is a change of slope the rod is put on the ground again and the angle of the new slope taken, and so on until the distance desired, each side of the main line, has been taken.

The topographer keeps notes of each angle of slope and the length of each slope, using plus signs for the angles of the slope where the ground rises and minus signs where the ground falls, and writing the length of each slope under its proper angle. The principal objection to this method is the difficulty of plotting the contours in the field, and wherever the notes only are taken in the field and then plotted in the office there is great chance of error.

The method of obtaining the required data by means of cross-section rods is as follows:

One end of the rod *a b* (Plate XV, fig. 3) is held at the station, resting on the ground, when the ground slopes down, and at the station, with the other end on the ground, when the ground slopes up. The rod is then brought to a level by means of the bubble *e*, and the vertical distance *b d* is measured by means of the other rod *c d*. The rod *a b* is then moved to *d*, and the same operation performed again, and so on until the required distance has been taken.

(TO BE CONTINUED.)

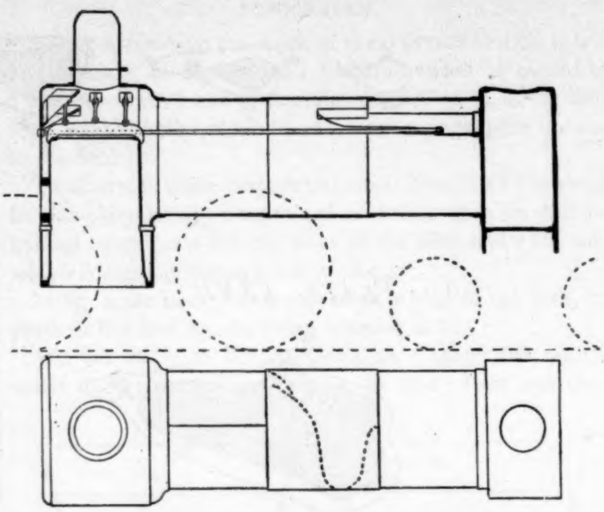
LOCOMOTIVE BOILER EXPLOSIONS ON BRITISH RAILROADS.

(*Continued from page 70.*)

WE continue below the condensed statements of the Inspectors of the Board of Trade of the results of their investigations into accidents on British railroads resulting from the explosion of locomotive boilers.

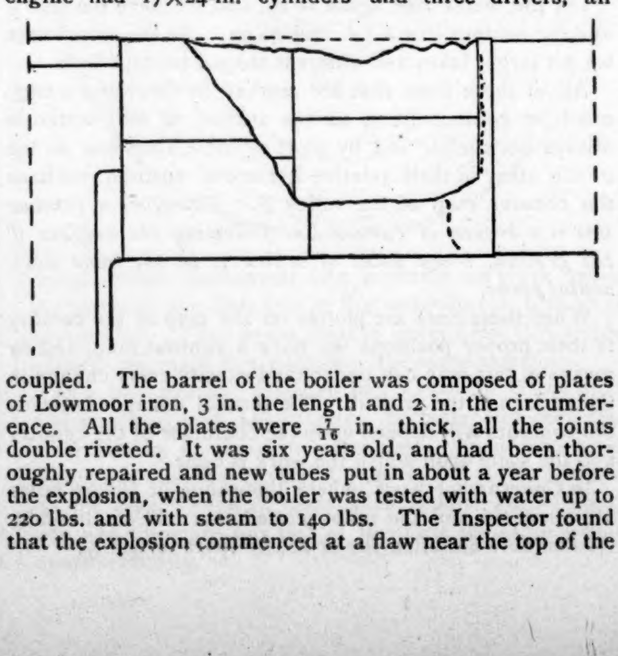
INSPECTORS' REPORTS.

September 24, 1878, the engine of a mixed passenger and goods train on the Great North of Scotland line exploded its boiler at Boat of Garten, just after the train had stopped at that station. One man on the engine was badly hurt, and two others escaped without any serious injury. The front plate of the barrel of the boiler was blown away about 600 ft. from the train, the middle plates torn across, and the frame and machinery of the locomotive badly damaged, the axles being bent and one wheel broken off from the axle. The engine was 15 years old, and had run about 352,000 miles in all. It was thoroughly repaired about a year before the explosion, when the boiler was tested up to 170 lbs.; the safety-valves were adjusted to 140 lbs. The engine had cylinders 16×22 in., four driving-wheels, and a four-wheeled truck. The barrel of the boiler was 45 in. diameter and 11 ft. long, and was formed of six plates, three in the length and two in circumference. The longitudinal seams overlapped $3\frac{1}{4}$ in. and were double riveted; the vertical seams $2\frac{1}{4}$ in., and were single riveted. The longitudinal seams of the middle plates were at the center



of the boiler, those of the end plates at the top and bottom. The plates were originally $\frac{7}{16}$ in. thick. The accompanying diagrams show a section and plan of the barrel of the boiler, the principal braces being shown on the sectional view. The dotted lines on the plan show the line of fracture. In this case the Inspector says: "There is very little reason to doubt that the explosion commenced along the bottom seam of the two front plates next the fire-box, grooving being very evident along the course of the seams in the left plate. The grooving was deepest near the center of the seam, leaving at points a very slight thickness of metal; otherwise the plates were in good order and were not much worn or pitted. The practice of making locomotive boilers with horizontal seams below the water line is now almost abandoned, on account of the liability of these seams to become grooved without a possibility of detection except when new tubes are put in or a leakage occurs."

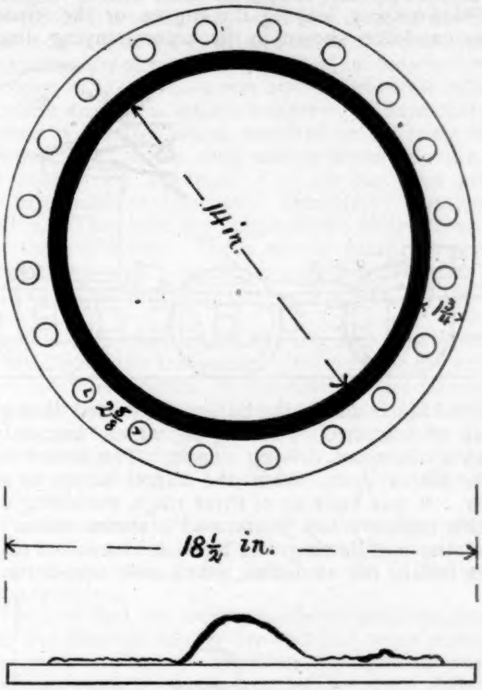
November 24, 1878, the boiler of the locomotive of a freight train on the Northeastern line exploded just after the train had stopped at Blaydon. Three men on the engine were badly hurt. The barrel of the boiler was almost destroyed, nearly the whole of the middle top plate, with portions of other plates, being blown away, while some other plates were cracked. The accompanying sketch shows the portion of the boiler which was damaged, the irregular lines showing the lines of fracture. The engine had 17×24-in. cylinders and three drivers, all



coupled. The barrel of the boiler was composed of plates of Lowmoor iron, 3 in. the length and 2 in. the circumference. All the plates were $\frac{7}{16}$ in. thick, all the joints double riveted. It was six years old, and had been thoroughly repaired and new tubes put in about a year before the explosion, when the boiler was tested with water up to 220 lbs. and with steam to 140 lbs. The Inspector found that the explosion commenced at a flaw near the top of the

lower middle plate. This flaw extended nearly the whole breadth of the middle plate, in parts leaving only a skin of sound metal. This fracture thus commenced ran through the joint next the front plates, then across the upper middle and rear plates. It is probable that the flaw referred to was due to some original defect in the plate, which had not shown itself when the boiler was examined.

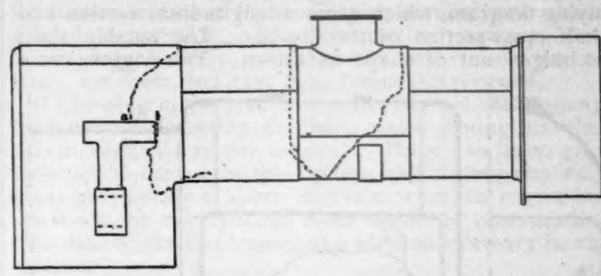
November 30, 1878, as a passenger train on the Great Western line was just starting from Penzance, the dome of the engine was blown off. No persons were hurt, but the cast-iron dome with its brass cover was blown into the air and came down through the roof of the station, while a small piece of the brass cover fell in the road 250 ft. away. The dome which gave way was 15 in. diameter, of cast iron ½ in. thick; it broke at the flange. The accompanying sketch shows a transverse section of the dome and a side view, showing the line of breakage. Subsequent examination showed a flaw in the metal about 9 in. long, extending nearly through, and another about 1 in. long extending about one-half through the iron. These



flaws and the break caused by the dome being blown away made a clean and nearly level fracture all around the flange. It appears that the engine was repaired about three months before; at that time the dome leaked in front, and it was thought that the leak was at one of the 20 studs by which it was fastened to the boiler. Three studs were renewed, and the boiler being tested with 120 lbs. pressure, no leak was noticed. The dome again leaked about a month before the explosion, when the joint was refitted. It is to be noted that the use of cast iron for the domes of boilers was an old practice, and at the time of this explosion had been abandoned, wrought iron being used on all new engines. The engine in this case was 26 years old. It was a tank engine with 17×24-in. cylinders and six wheels 5 ft. diameter.

September 9, 1879, the boiler of the engine of a coal train on the Northeastern Railway exploded just after the train had started from Leamside station. The engineer and firemen were badly hurt. The barrel was torn to pieces, and a number of the tubes were torn out; pieces of the iron were picked up 1,000 and 1,200 ft. distant. The engine had 17×24-in. cylinders and six wheels, all coupled. It was built in 1871, and had run 250,000 miles. The plates were all Lowmoor iron $\frac{7}{16}$ in. thick; there were six in the barrel of the boiler; the horizontal joints were all lap joints. The usual working pressure was 130 lbs. There was no reason to suspect tampering with the safety valves or unusually high pressure. The fracture commenced on the right side, and there was some grooving along the line marked *a b* in the accompanying diagram, where a hanging stay was attached to the outer shell; with the exception of this slight grooving the edges of the plates where broken showed no signs of deterioration. The Inspector says:

"The boiler had never been tested since it commenced running, when it had been submitted to the usual hydraulic pressure of 220 lbs. to the square inch, nor had an opportunity offered for making any internal examination since



October, 1872. The Locomotive Superintendent informed me that the reason this boiler had not been tested was that it was a comparatively new one, and had shown no symptoms of deterioration, though it would in course of a short time have been tested.

"It appears to me that seven or eight years of hard running is too long a time for any boiler to work without being tested or internally examined, and that it would be only wise to establish a rule that all boilers should be tested at regularly recurring periods of considerably shorter duration.

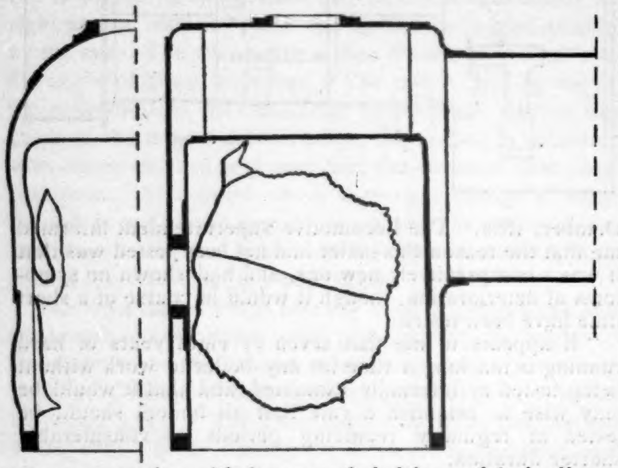
"The method, too, by which this boiler was supported —viz., by rigid connections to the side of the outer shell of the fire-box, thereby interfering with the free expansion and contraction of the boiler lengthways, is now but rarely used."

September 16, 1879, the boiler of the engine of a freight train on the Northeastern Railway exploded while the train was between Headingley and Horsforth. The train at the time was running up a grade of 1 in 100 at a speed of about 10 miles an hour. The engineer was slightly hurt. This was one of the rare cases of a boiler exploding while the locomotive was in motion. Nearly two-thirds of the barrel of the boiler was blown away to some distance, the frames of the engine were bent, and the running gear very badly damaged; the crank axle was broken off at one of the angles. The engine had 16×24-in. cylinders with six wheels 57 in. diameter, all coupled. The boiler was 46 in. diameter of barrel and 10½ ft. long. It was originally built in 1848, and the engine had run 665,000 miles. The barrel originally consisted of six plates $\frac{7}{16}$ in. thick, three in the length and two in the circumference. These did not break joints. The horizontal joints were opposite each other about one-half way up the barrel; the vertical joints were lap joints. The boiler was repaired in December, 1878, when the bottom plate was patched and a new piece of plate fitted in the full length of the original plate, but only 30 in. wide, thus making the lower half of the boiler of three narrow plates. So far as could be ascertained, the rest of the plates were those originally put in in 1848.

The Inspector believes that the explosion was caused by the giving way of the side and bottom plates of the boiler, in which the thickness of metal had been reduced to ¼ in., and in one place to ⅛ in., by corrosion. The explosion seems to have started along the joint between the old and new plates mentioned above. Besides the corrosion some of the old plates showed signs of considerable brittleness. The Inspector also thinks that it is not right to continue in active use boilers as old as this one was; he also doubts the correctness of the plan of riveting new plates to old ones. Fortunately it is an unusual thing to find boilers of so great age still at work.

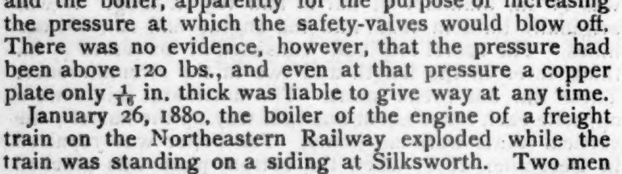
September 25, 1879, an engine of a passenger train on the London, Brighton & South Coast line exploded its boiler just after the train had stopped at Lewes station. The engineer was killed and two other men badly hurt. At the time of the explosion the engine was taking water

from the tank, and its force lifted it from the rails and threw it over on the platform of the station. The explosion was caused by the breaking of the left side plate of the fire-box, which gave way along the horizontal line between the second and third rows of rivets from the bottom of the box. The plate was torn from the stay-bolts and the piece, extending nearly the whole length of the fire-box, was folded over against the inside upper part of the sheet. The nature of the break is shown in the accompanying diagram, which gives a longitudinal section and a half cross-section of the fire-box. The outside sheet was bulged out of shape as shown. The engine was a



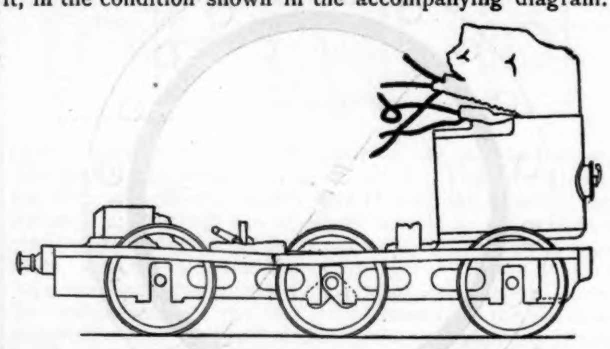
passenger engine with four coupled drivers 6 ft. in diameter, and leading wheels 4 ft. in diameter; the cylinders were 16×20 in. It was 15 years old, and in 1870 had been repaired and a new fire-box and tubes put in. Since receiving [the new fire-box it had run 305,000 miles. The engine had been in the shops only a few days before the explosion in consequence of the tubes leaking; and at that time the boiler-maker examined the boiler. At the investigation he stated that he had found the fire-box plates on the right side badly worn, but he had not reported this fact. The fire-box was of copper, the plates originally $\frac{7}{16}$ in. thick. The examination showed that at the point where the plate gave way it had been reduced to about $\frac{1}{16}$ in. The safety-valves were set at 120 lbs. This reduction of the copper sheet was quite sufficient to account for the explosion, though there was also evidence that plugs of waste had been jammed in between the spring-balances and the boiler, apparently for the purpose of increasing the pressure at which the safety-valves would blow off. There was no evidence, however, that the pressure had been above 120 lbs., and even at that pressure a copper plate only $\frac{1}{16}$ in. thick was liable to give way at any time.

January 26, 1880, the boiler of the engine of a freight train on the Northeastern Railway exploded while the train was standing on a siding at Silksworth. Two men were injured. The ring of the boiler barrel next the fire-box and part of the outer shell of the fire-box were completely torn away, the frames were bent, and the engine badly damaged. The engine had 17×24-in. cylinders and six 5-ft. wheels, all coupled. The barrel was 11 ft. 4 in.

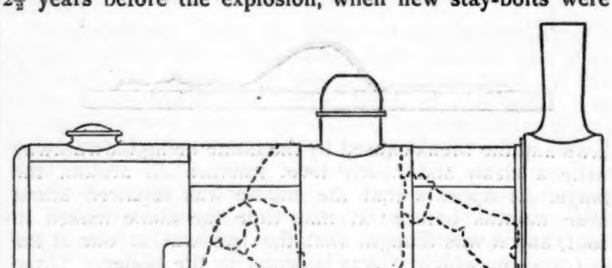


long and 50 in. diameter. It was of the telescope form, of iron plates $\frac{7}{16}$ in. thick, with all seams double riveted; the outer shell of the fire-box had plates ⅜ in. thick. The engine was nine years old, had been repaired in 1875, and the boiler had been tested to 200 lbs. two years before the explosion. The safety-valves were set at 125 lbs., and just before the explosion steam was blowing off. The accompanying sketch shows the general form of the boiler, the dotted lines being lines of fracture, while the line *a b* shows the line of corrosion referred to below. Examination shows that on this line *a b* there was deep grooving in the lower plate along the seam, extending through almost its entire thickness. This was probably due to the proximity of the joint to the plate attached to the side of the fire-box, which rested on another plate attached to the frame. The bearing surface being considerable, a great deal of resistance was offered to expansion and contraction. The strains thus put upon the joint were probably the original cause of the grooving. There seems to be no doubt that the rupture started on this line.

November 12, 1880, the boiler of the engine of a freight train on the Northeastern Railway exploded while the train was standing at Rainton Crossing. The engineer and fireman were both badly hurt. The barrel was completely blown away, leaving the engine, or the remains of it, in the condition shown in the accompanying diagram.



The second figure shows the boiler, the dotted lines giving the lines of fracture. The engine, which was six years old, had six coupled driving wheels. The boiler was of iron, the plates $\frac{7}{16}$ in. thick, the barrel being 50 in. in diameter. It was built up of three rings, each ring of one plate with ordinary lap joints, and a steam dome in the center of the middle ring. It had been repaired in 1878, 2½ years before the explosion, when new stay-bolts were



put in the fire-box. At that time it had been tested up to 220 lbs.; the usual working pressure was 130 lbs. It had never, however, been carefully examined internally.

The Inspector says that the barrel was broken off in 11 pieces, which were scattered in every direction. From a careful examination there appears to be no reason to doubt that the cause of the explosion was top grooving along the horizontal joint of the middle plate. This joint was 15 in. below the water line, and was grooved more or less along the whole of its length, the sound metal being in parts not more than $\frac{1}{16}$ in. thick. The plate also was not of very good material. The Inspector says, in conclusion, that the explosion of this nearly new boiler raises several questions.

"1. Whether every boiler should not be submitted to internal inspection after running a certain number of miles, say 100,000.

"2. Whether boiler barrels should not be made with butt joints rather than lap joints, so as to insure their being

perfect cylinders, and thus to making contraction and expansion as uniform as possible for the joints of the barrel.

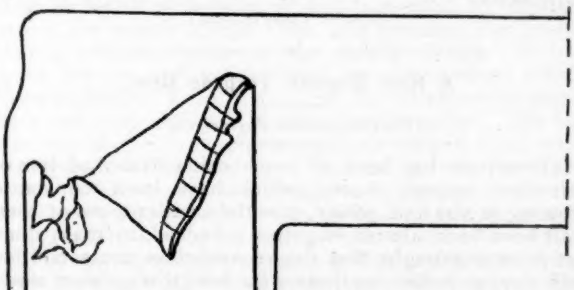
"3. Whether with boiler barrels made with one plate in each ring the joints should not be arranged in all cases so as to be above the water line."

December 26, 1881, as a freight train on the Northeastern line was drawing into a siding behind a coal train at Thornaby Iron Works, the fire-box of the boiler exploded. The boiler was thrown forward and deposited on the fifth or sixth car from the rear of the coal train, striking as it passed the brake-van of the coal train, and setting it on fire. The wheels of the freight engine and its tender were thrown off the rails, and the cars of the freight train were thrown backward about 100 ft. along the track by the shock. Three men on the freight train and two on the coal train were killed. This engine was built at the company's shops in 1880, and was only about two years old at the time of the explosion. The fire-box, which exploded, was of copper and of the usual form, its internal dimensions being 4 ft. 5 in. long, 3 ft. 4 in. wide, and 5 ft. 10 in. high. It was made of copper plates ½ in. thick, and was stayed in the usual way with ⅞ in. copper bolts 4½ in. between centers, at the ends and sides. The crown-sheet was supported by seven crown-stays 4¾ in. between centers. there being in each crown-stay 10 wrought-iron bolts 1 in. in diameter and 4½ in. between centers. These stays were supported by hanging stays attached to the outer shell of the fire-box. A fusible plug was screwed into the center of the roof of the fire-box. The fire-box was provided with a brick arch or deflector. The safety-valves were set at 140 lbs. They had been cleaned and tested three weeks before the explosion. There was a glass gauge so arranged that no water would be visible in the glass unless there was about one inch of water above the top of the fire-box.

A careful inspection of the fire-box and consideration of the evidence led the Inspector to believe that the explosion was probably occasioned by the crown-sheet having been too much heated, owing to low water, and then unable to resist the pressure caused by the sudden creation of steam upon water being admitted into the boiler just as the engine run in the siding at Thornaby Junction. The reasons for this belief are:

1. The appearance of scorching on the copper plate near the place of fracture, which was over the fire-door; the same appearance also being visible on the adjoining heads of the stay-bolts.

2. The fact that the engine had been less than two years in use, and that the copper fire-box and stays were generally in good condition. Whether the want of water was due to carelessness on the part of the dead driver or to



some defect of the water-gauge having misled as to the height of water, it is not possible to say. The accompanying diagram shows the rear end of the boiler as it appeared after the explosion.

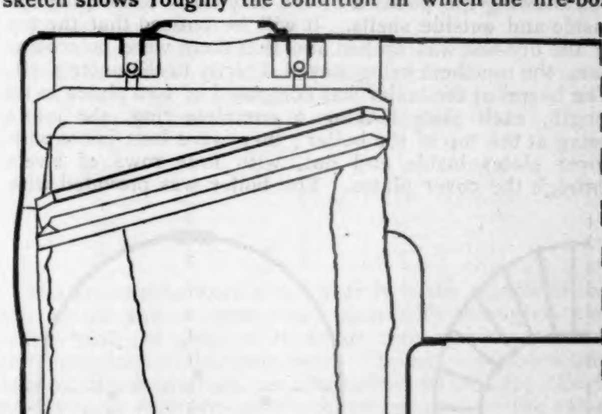
The comments of the Inspector on this accident are as follows:

"The difference of level between the top of the boiler and the crown of the copper fire-box, amounting only to about 13 in., was certainly small in the case of this engine, and would, of course, quickly allow the crown of the fire-box to become uncovered without very constant attention. I am not aware of the greatest difference of level which exists, but I know that some locomotive engineers keep down the crown of the fire-box 20 in. below the top of the boiler, and that 15 to 18 in. is a common difference of level. So small a difference as 13 in. should, as far as possible, be avoided.

"The failure of the lead plug (which had been removed from the fire-box by order of the Locomotive Superintendent soon after the explosion) to melt when the crown of the fire-box became heated appears to have been owing to the bottom surface of the lead having become covered with a hard incrustation. Some locomotive engineers think these plugs entirely untrustworthy; others, on the contrary, use them, but have them frequently renewed.

"The plug in the present instance had not been renewed for four or five months, the boiler-smith stating that there was no regular time for renewal. There can be no grave objection to the use of these plugs, and if their renewal is made peremptory at short intervals, when an engine is in the sheds for overhauling, there would be comparatively little fear of their not being in a state of efficiency in case of need."

February 10, 1882, the boiler of the engine of a freight train on the Great Eastern line exploded just after the train had stopped in front of the freight house at Bury St. Edmunds. The driver, fireman, and guard, who were all on the engine, were very badly scalded. The failure in this case was of the fire-box, which was destroyed; no fragments were thrown away. The force of the explosion lifted the rear end of the engine off the track and threw it across the opposite line; the coupling between the engine and tender was broken and the train thrown backward, the tender and a car being thrown from the track. The engine had four driving wheels and a four-wheeled truck; it was 17 years old, and had run 204,000 miles. In 1876, about 5½ years before, it had been supplied with a new boiler and fire-box. This boiler was made of Yorkshire iron ¾ in. thick, except the tube-plate, which was ½ in. This boiler when new had been tested up to 240 lbs.; the usual working pressure was 140 lbs. In 1880, two years before, a new set of tubes had been put in, and at that time the fire-box was carefully examined, some slight repairs made, and some new stay-bolts put in. The accompanying sketch shows roughly the condition in which the fire-box

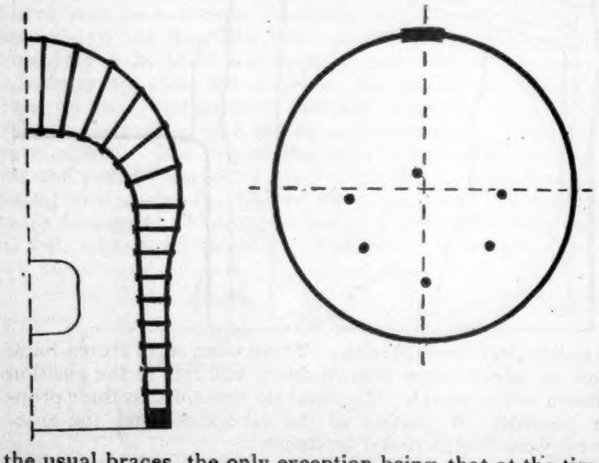


was left after the explosion. There were eight crown-bars, two of which were thrown down and left in the position shown in the sketch; the other six remained in their proper position. A portion of the tube-sheet and the side-sheet were folded round as shown.

The Inspector says that, from a careful consideration of the evidence and inspection of the fractured fire-box, there is little reason to doubt that the explosion was due to the defective condition of the copper stay-bolts. Three of these, a little below the center and near the forward end, were found to show old fractures. The fire-box evidently began to give way at this point by the steam pressure first bulging the copper plate, then stripping it away from the

unbroken stay-bolts, and at the same time breaking a number of them which appeared to be cracked. There is no reason to suppose that there was any excess of steam pressure. Three days before the engine-driver had reported that there was some leaking at the stay-bolts, and these leaks had been temporarily closed up by a boiler-maker, who reported to the foreman that the stay-bolts were getting into bad condition, and that a number of them required renewing. The Inspector blames the foreman for allowing the boiler to continue in service in this condition.

September 1, 1882, the boiler of the engine of a freight train on the North British Railway exploded near Dunbar just after the train had stopped at a water-tank to take water. The explosion killed the driver and fireman, and a third person unknown, who, it is supposed, had been riding on the engine without proper authority. The boiler was thrown by the explosion over on the opposite track, causing the wreck of a freight train which was approaching on that track. The engine was six years old, and had run 180,000 miles. It had received general repairs six months before; since that time it had been running, and there had been no reports made of anything wrong with the boiler. A slight examination of the fire-box had been made three days before, when it was reported all right. The results of the explosion were extraordinary in the complete destruction of the boiler and the distance to which many of the fragments were thrown. The principal force, apparently, was exerted to the left hand, a large piece from the left side of the barrel having fallen nearly 1,500 ft. away, while another piece was picked up 800 ft. away, somewhat in advance of the engine. Nothing was left standing above the level of the frame of the engine, which was much bent out on one side. The driving axle was broken. The fire-box was blown into three pieces, which were thrown in different directions. The smoke-box and smoke-stack were thrown forward about 300 ft. The safety-valves, it appears, were set at 137 lbs., and the evidence shows that they had been in good order a day before the explosion. The construction of the boiler and fire-box presented no special features. The accompanying diagram shows a section of the barrel of the boiler, which was 54 in. in diameter, and also a half section of the fire-box showing the position of the stay-bolts connecting the inside and outside shells. It will be noticed that the top of the fire-box was arched and that there were no crown-bars, the top-sheet being stayed directly to the outer shell. The barrel of the boiler was composed of two plates in its length, each plate making a complete ring, the joints being at the top of the boiler; they were butt joints with cover plates inside and out, with four rows of rivets through the cover plates. The boiler was provided with



the usual braces, the only exception being that at the time it was last repaired six of the tubes were taken out and were replaced by six longitudinal iron stays running from the front to the back tube-plate, and secured at each end by nuts screwed on. The position of these stays is shown in the cross-section of the barrel.

The Inspector says that the cause of this explosion is involved in obscurity. The engine was comparatively new, and the boiler appears to have been in good condition. The fact that all the men on the engine were killed makes it still more difficult to ascertain whether there was any special cause. A careful examination failed to show any corrosion of plates or bad material sufficient to account for the accident. Some pitting was observed, but very slight, and of the broken stay-bolts very few appeared to be at all defective. The only theory which he is able to suggest was that the explosion was caused by the sudden generation of steam of very high pressure. The fire-box crown-sheet, however, did not show any signs of scorching or of low water, and this theory must be accepted with some caution, especially as there was a fusible plug in the crown-sheet of the fire-box which was nearly new, and which showed no signs of melting.

The returns of the companies for the year 1878, as summed up in the report of the Board of Trade, show that there were 10 cases of bursting of boilers or tubes of locomotives, by which 14 persons—all railroad employés—were injured. Three of these cases were specially examined into and reported on, as shown above; the others, apparently, were slight cases of not sufficient importance to require investigation.

In the year 1879, the Board of Trade returns showed that there were five accidents from bursting of boilers and tubes, by which one person was killed and eight hurt. Two of these were of slight importance; the other three were sufficiently serious to require investigation, and the reports are given above.

For the year 1880 the reports mention four cases of explosions of boilers or collapse of tubes, in which one person was killed and five hurt. Two only of them were investigated, the rest being of slight importance.

During the year 1881 there were reported seven cases of the bursting of boilers and tubes of engines, by which five employés of the railroad companies were killed and four injured. This year only one of these cases was inquired into—the explosion in which five employés were killed; the others were of slight consequence, apparently, as no investigation was made.

In 1882 two cases were investigated and reported on, out of a total of four reported, in which three persons were killed and five injured. The other two cases only were of importance.

(TO BE CONTINUED.)

A New English Torpedo Boat.

(From the London *Engineering*.)

ATTENTION has been so much concentrated of late on first-class torpedo boats, which have been constantly growing in size and power, that the smaller types of these craft have been almost forgotten. Indeed, in many quarters it was thought that the second-class boats had had their day, or rather (as those who hold this opinion would put it) that the craze for them was past. There was a good deal of reason for this opinion; for the old second-class boats were, as is well known, designed especially for hoisting on board ship, a position in which they are a consummate nuisance. The counterbalancing advantages to be expected from these craft in war are, at the least, problematical, and in peace time they are absolutely no good at all. The chief drawback is their unseaworthiness, and this is due greatly to their want of stability. The later vessels built are 63 ft. long and 7 ft. to 7 ft. 3 in. wide. It is true that on some few occasions second-class torpedo boats have been out in pretty rough weather for craft of their size, but although they struggled through without foundering, a ride on their decks more resembled a passage on the back of a porpoise than the average notion of steam navigation.

It has hitherto been maintained that, in order to secure speed it was necessary these boats should not exceed the breadth of beam heretofore accorded to them; and, as speed is considered of paramount importance, seaworthiness has had to give way. The Admiralty authorities have, however, not entirely supported this view of late, and a recent addition to the English Navy has proved that more could be done, both in the matter of speed and stability, than was before considered possible, within the limits of length necessary for a second-class boat. Messrs. Yarrow & Co., of Poplar, a short time back made a contract with the Admiralty to build a vessel which was to have higher speed and greater beam than the existing boats, and this without exceeding the limit of length prescribed by the exigencies of lifting and stowing on shipboard; as a matter of fact, the boat in question is 3 ft. shorter than her immediate predecessors, being only 60 ft. long over all, while she has a breadth of 8 ft. 6 in.

One or two preliminary runs have been made during the last month or two, since the boat was completed, but the official trial was made the week before last with very satisfactory results. Before, however, we consider the boat's performance it will be well to give a few of the leading elements of her design.

No. 50 second-class torpedo boat—for this is another official designation of the craft—is, as already stated, 60 ft. long by 8 ft. 6 in. beam. She is flush decked, and has a freeboard of 3 ft. 6 in., which gives a good height above water. We lately had an opportunity of seeing the boat hauled up on the slip, and could not help admiring the skill with which the conflicting elements of speed and stability were combined in the model. The bilge is carried well down, and there is a good floor, and yet the entrance is fair and easy, the lines merging into each other in a very pretty manner. The additional beam—the latter now having the wholesome proportion of one-seventh of the length—gives, in fact, the naval architect a fair chance of displaying his skill in design, and the question of speed is not so exclusively one of hard driving. The metacentric height is, we understand, about 1 ft. Forward there is a turtle deck, the after part of which is raised into a rectangular conning tower, extending right across the deck. The boat is propelled by one two-bladed screw. The deadwood aft is cut away and the rudder is of the balanced type, the description of stern being that adopted by Messrs. Yarrow & Co. in their most recent first-class, a mode of construction designed by the firm, in 1881, for some boats built for the Chilian Government. The hull of the vessel now under notice is of course of steel, and has fore-and-aft butt straps outside, so as to give a better countersink to the rivets.

The boiler is, generally, of the type used by Messrs. Yarrow for vessels of this class, and contains the distinguishing characteristics of the firm's design. It has copper fire-box and taper tubes; an arrangement which allows additional water space near the furnace tube plate, where the evaporation is naturally most rapid. The engines are of the three-crank triple compound type, with piston valves to all cylinders. They are, in fact, duplicates of the firm's first-class boat engines, excepting, of course, that they are on a smaller scale. The air and feed pumps are worked by a crank on the fore end of the crank-shaft.

There are the usual fan engine and centrifugal pumping engine for supplying cooling water to the condenser. The latter, however, is mainly supplied with water for condensation by means of a natural circulation, set up by the passage of the boat through the water. When the boat is at rest or going astern the centrifugal pump is brought into play. Under the turtle-back and conning tower forward there is a cabin extending up to the collision bulkhead. This will afford accommodation for 12 to 14 men. The hand steering gear is placed in the conning tower, there being no steam steering gear in this vessel, the ease with which she turns, owing to the improved shape, enabling this extra complication to be avoided. Abaft the machinery space there is a good cabin intended for officers, but which will accommodate 12 men if necessary. It has side lights, there being no raised structure for skylights, as the deck above has to be flush in order that the torpedo gun may be worked. Right in the stern there is a good room for stores and gear.

The armament will consist mainly of a torpedo gun placed on deck, and which will swivel on the engine-room after bulkhead. In this way a very wide angle of ejection for the fish torpedo will be obtained on both sides, without moving the boat. It is considered that the firing of a torpedo in this way is more effective than the simple end-on fire of the built-in bow torpedo tubes. These can only be directed by manœuvring the boat itself, which must of course be brought bow-on with the enemy. In such firing the boat has to be very much slowed down, and it is very difficult, or in rough water impossible, to point a boat with accuracy if her speed be too much checked. Of course these conditions as to difficulty in pointing do not apply with the swivel-gun arrangement, for the enemy has only to be brought on anything approaching a broadside, and the weapon can be easily directed. Moreover, it is said that a very fair approximation to accuracy of aim with a Whitehead torpedo can be attained when these boats are running at a high rate of speed. Of course there must be considerable disturbance due to the lateral motion imparted to the torpedo through being carried by the boat, but it is found that with a little practice this can be allowed for, and at short ranges there is small chance that the weapon will not hit the ship. In any case, however, the broadside ejection possesses great advantages, as it gives the torpedo boat a chance of striking her blow with less necessity for diverging from the straight line of approach and retreat. But to manœuvre a 15-ft. torpedo gun carried on the deck of a second-class boat requires more stability than those craft have hitherto possessed, and here it is that the extra width given to this boat has enabled a very considerable advance to be made in torpedo boat practice, a step which probably will do much to re-establish the second class in the good opinion of naval tacticians. From a peace-time point of view the advantages are still greater, for such a craft as Messrs. Yarrow have constructed will be available for the ordinary steamboat work of a man-of-war, more especially as the weight has not been increased in spite of the increased beam and speed; the lifting weight being 11¼ tons. There is a 1-in. Nordenfelt gun forward, and the boat is so arranged that a larger machine gun can, if necessary, be readily substituted for the torpedo gun.

Turning to the performance of the boat, the official trial made the week before last gave the following figures.

The trial consisted of a full-speed continuous run of four hours' duration, the load carried being four tons. The result obtained was a mean speed slightly exceeding 17 knots. During the trial the measured mile at Long Reach was passed over six times, with the following results:

Mile.	Time. Min.	Sec.	Mean Speed.
1	4	3	14.815
2	3	9	19.048
3	4	1	14.938
4	3	7	19.251
5	4	3	14 815
6	3	6	19.355

The above runs were made exactly in the middle of the four hours, and as steam was kept steadily throughout the entire trial, the mean of these six runs was accepted by the authorities as the true speed. The steam pressure was 160 lbs.; the revolutions, 520; the indicated H.P., 225. Each of the three cylinders gave within 8 per cent. of the same power. Circles were turned to port and to starboard, with a view to ascertaining the manœuvring powers of the boat. The diameters of these circles were 135 ft. and 165 ft., the times being 40 and 49 seconds respectively; there was very little heel.

In considering these figures, it is fair to remember the new conditions under which this boat has been tried. In the first place, she is 3 ft. shorter and 1½ ft. wider than the majority of the second-class boats. The trial weights have also been raised from 2½ to 4 tons, an increase of 60 per cent. The duration of the trial has also been extended from two to four hours, a very material point. It is claimed that the extra 1½ tons in load represent one knot in speed, and the additional two hours of trial at least something above half a knot. The average speed of the earlier second-class boats was 16½ knots, so that in No. 50 the Admiralty has acquired a boat about two knots faster, to say nothing of the higher seaworthy and fighting qualities due to increased beam.

It is interesting to compare this little vessel with her forerunners of 10 years ago. In 1878 the speed of the second-class torpedo boat was 15½ knots—this, if our memory serves us, was the top record—with two tons on board; now we get over 17 knots with four tons of stores, gear, etc. Then the trial extended over a distance of 6 knots only; No. 50 covered above 11 times that distance on her official trial. In 1878 torpedoes were ejected from cradles which had to be lowered into the water alongside, to effect which operation the boat had to be brought to a stand-still. Having then hardly any movement through the water, she would have next to no steerage-way; practically, therefore, no aim could be taken except in the smoothest water, and even then the torpedo could only be directed in a line parallel to the keel. In fact, the whole business was little better than a farce from the point of view of actual warfare. Now the weapon can be ejected by a single movement of the officer in charge, through a range of angle embracing the greater part of the horizon, while the training is done from below. The increased manœuvring powers due to the improved form of stern are also an important factor in estimating the relative value of the types of the two periods. Another point that may be mentioned is the absence of vibration, a feature very characteristic of No. 50.

It is satisfactory to think that this improved boat has been built for our own Navy, and we congratulate the Admiralty officials upon their foresight and perseverance.

Twelve-ton Steam Traveling Crane.

THE accompanying illustrations (from the London *Engineering*) show a 12-ton steam crane of the "Goliath" pattern, in use at the works of the Darlington Wagon & Engineering Company, Limited, at Darlington, England. The iron work of the crane was made by that company, the engines by Job Isles, of Leeds.

The crane has a span of 60 ft. from center to center of the main rails, and a clear height of 28 ft. from the head of the main rail to the lowest portion of the fish-bellied girders. It is driven with a pair of diagonal engines, having cylinders 6½ in. in diameter by 10-in. stroke, with reversing link motion, and a solid disk crank. The boiler is made of B B Staffordshire plates ⅜ in. thick. It is 8 ft. high and 3 ft. 6 in. in diameter inside, and has a circular internal furnace with three cross-tubes. It was tested to 150 lbs. pressure with water.

The crab consists of strong iron frames and runs on cast-iron double-flanged wheels. One pair of wheels is driven from the engine by a double friction clutch worked by a hand-wheel and screw from the engine platform. The crab can be racked across at the rate of about 40 ft. per minute, with the full load hanging on the crane and the engines running about 120 revolutions per minute.

The hoisting gear is of single and double purchase. The fast speed of lifting is about 18 ft. per minute, and

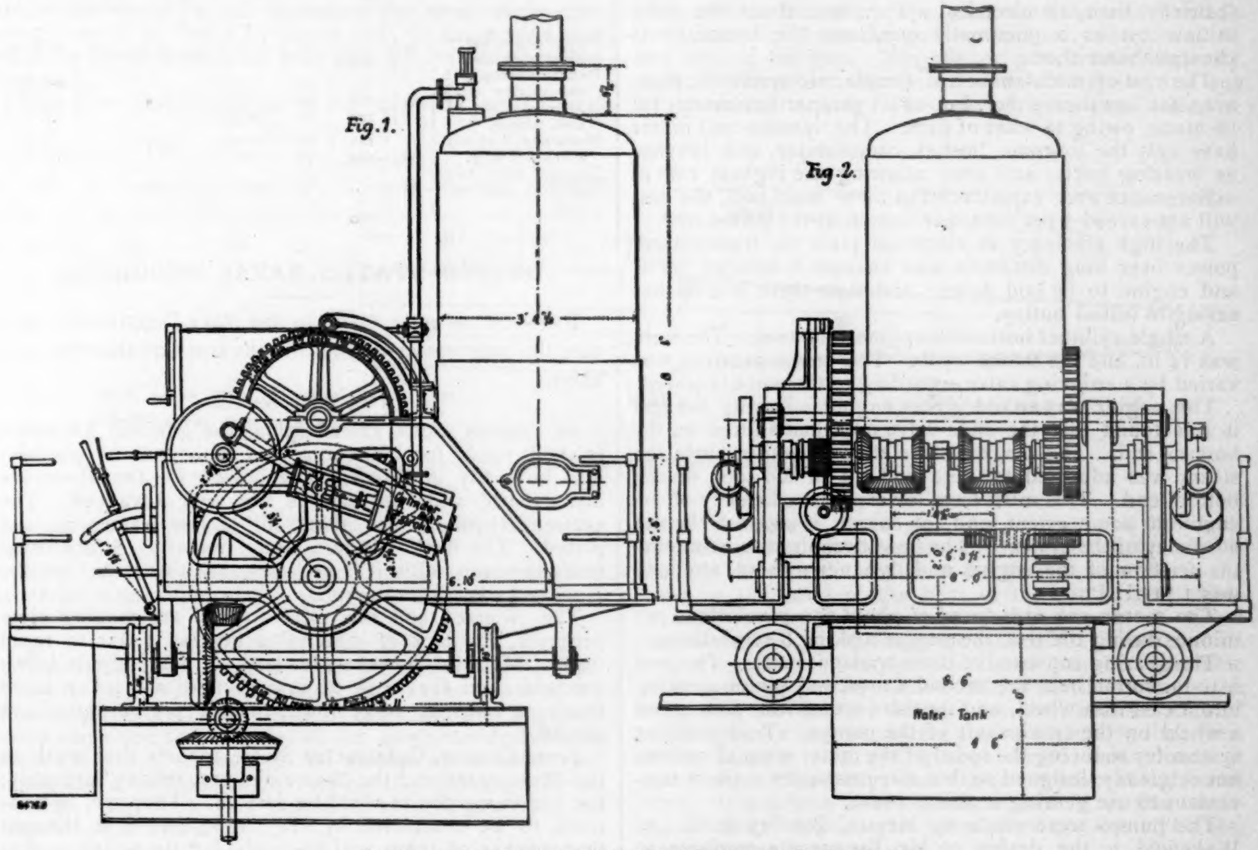
TWELVE-TON STEAM "GOLIATH" CRANE AT THE DARLINGTON ENGINEERING WORKS, DARLINGTON, ENGLAND.

the slow speed with the full load on not less than 10 ft. per minute, with the engines running about 120 revolutions per minute. The main barrel has double right and left-hand steel ropes, so as always to lift square. It is turned all over where the ropes run. The pulleys are all turned where the ropes run, and have steel pins. The barrel lies parallel to the main girders, and its position is so arranged that half the weight comes on each main girder.

The whole crane is driven along the main road by engine power. There are two speeds for this traveling. With the engines running at 120 revolutions per minute, the light crane travels 60 ft. per minute, and the crane with the full load on 40 ft. per minute. This motion is derived from a double friction clutch worked by a hand-wheel and screw convenient to the engine platform. The cross gantry shaft is of steel, and runs in self-acting tumblers. The vertical shaft is of steel also. There are four main traveling wheels, all driven from the engine. The vertical shafts and all their bevel wheels are outside the framework, so as not to reduce the clear span of the crane. The main wheels have steel tires bored and shrunk on, but not turned on the tread.

The ordinary working load is 12 tons, but the crane was tested with 15 tons in the center, and bore this load satisfactorily.

The larger engraving is a general view of the crane. The other cuts are a side view and an end view of the engine and boiler.



ENGINE FOR TWELVE-TON STEAM "GOLIATH" CRANE.

Pumping by Electricity in Coal Mines.

(From the London *Electrical Review.*)

THE electrical pumping plant hereafter described was built by Immisch & Co., of Kentish Town, London, and erected under their superintendence; the steam power, the pumps, and the piping being supplied by the colliery owners. The particulars and a test of the plant are to be found in the table appended, and will serve to show that, even with ordinary steam-engines and pumps not designed for use with electric plant, the commercial return of useful work is very high. Indeed, the efficiency of electrical plant is as much as 66 per cent. in favorable cases. And, since the efficiency falls off very slowly with the increase of distance through which the power has to be transmitted, this method of driving pumps should find favor in mining circles.

Where steam can be used direct, or be easily carried by lagged pipes, and in most cases where the power can be transmitted by a system of ropes, the electrical engineer will not enter the lists. Electricity really competes with compressed air and hydraulic plants.

Comparisons which have been made show the following results:

Compressed Air Plant.—Pneumatic plant entails a large initial outlay, gives considerable trouble while running, from heating at the compressors and freezing at the exhaust ports. The running expenses are also very heavy. The losses in transmission through horizontal pipes for long distances are also considerable. Against these must be set off the fact, that there is a slight increase of pressure when vertical pipes are used for any part of the way, and that the exhausting of fresh cold air is, near the "faces" at any rate, a great boon.

Hydraulic Plant.—Water under pressure is in many cases a very cheap and convenient way of transmitting power, and if there be a sufficient head to do away with the need of a pumping engine and accumulator on the surface, there is much to be said in its favor.

In most cases, however, an engine and accumulator will be required on the surface, and heavy costly piping has to be laid down. The chief drawback is that water has to be taken down the mine to raise water already there. Cases are known where a gallon of water at high pressure was used for every two gallons raised.

The plant is costly, and, if working at high pressure, gives continual trouble by blowing of joints, etc. The cost of maintenance is thus sometimes considerable.

Electrical Plant.—The requirements for this are a

steam-engine and boiler, a dynamo, motor, and connecting copper cables.

The engine and boiler may be taken as common to all the systems, and the cables are comparable with the piping used in the other systems. The cable is, however, less per foot run than either cast or wrought-iron piping to transmit the same energy, and the cost of erection is far less since there is no jointing to be done. The cable is cleated to the cross timbers on the roofs in a simple and cheap manner.

We have now only the dynamo and motor to compare with the compressors, accumulators, and air-engine of the pneumatic system, or the accumulators and engine of the hydraulic. It will be found that the air compressors, accumulators, and air-engine cost about as much as the dynamo and motor for a similar output. The hydraulic accumulators and engines will cost less than the dynamo and motor, but the want of efficiency and other drawbacks mentioned more than counterbalance this apparent gain in prime cost.

Briefly, then, an electrical system has about the same initial cost as a pneumatic one, and the hydraulic is cheaper than either.

The cost of maintenance of the electric system is, however, far less than either, but exact comparison cannot yet be made, owing to want of data. The dynamo and motor have only the journals, bushes, commutator, and brushes as wearing parts, and even allowing the highest rate of maintenance ever experienced in these machines, the cost will not exceed 5 per cent. per annum of the prime cost.

The high efficiency of electrical plant for transmitting power over long distances also enables a smaller boiler and engine to be laid down; and thus there is a further saving in initial outlay.

A single cylinder horizontal engine was used. The bore was 14 in. and the stroke 15 in. The steam pressure was varied by a reducing valve according to the work required.

This engine was an old girder engine. During the test it was found that the slide-valve nuts had shifted on the bottom end. The diagrams are thus defective, since the steam was admitted too late and cut off too soon on the bottom end. This must have lowered the efficiency of the engine to some extent, and, of course, is against the net efficiency of the system. The power required to overcome the friction of the engine and dynamo without any load was 1.715 H.P.

The motor ran at a speed of about 650 revolutions per minute during the test, the pumps making 8 revolutions.

The gearing consisted of three transmissions. The first a 10-in. cotton belt, the second a mortised pinion gearing into a cast-iron wheel, and the third a cast-iron pinion and a wheel on the crank shaft of the pumps. This complex system for reducing the speed of the motor was, of course, not originally designed so, but circumstances made it convenient to use gearing in this manner.

The pumps were made by Messrs. Bradley & Co., of Wakefield, to the design of Mr. Brown, the engineer at the colliery. They consisted of two separate differential pumps. Each had one 6-in. ram, and one 4½-in. ram. They were coupled by cross heads and connecting rods to the main shafts with the cranks at right angles.

The suction was only made by the 6-in. rams, but all the rams delivered water into the column; there were thus two sections and four deliveries per revolution of the crank shaft, the pump being equivalent to a four-throw pump with 4½-in. rams.

The division of the work done by the large rams was not by any means equal. Though to casual inspection the work done throughout a revolution was constant, an ammeter in circuit with the motor showed considerable fluctuations of current at regular periods. The difference of load thus experienced was as much as 25 per cent., and caused at first some trouble by heating the armature and pole-pieces, if the average current exceeded 50 ampères.

This difficulty, however, was successfully overcome. The same plant was tested under different circumstances about three weeks before these tests were made, and the conversion was then 42 per cent. with a delivery of about 42 gallons per minute through 850 ft. The rise of efficiency to 44.4 per cent. is probably due to the friction of the bearing surfaces being lessened by wear and by the shortened length of piping. But more so by the introduction of the belt transmission which protected the motor from the vibration, which is inseparable from high-pressure pumping plant.

We may mention that this plant is giving great satisfaction, and that the colliery owners, Messrs. Locke & Co., have given the makers, Messrs. Immisch & Co., an order for another dynamo and motor to deliver 120 gallons per minute, through a head of 900 ft. The plant is already in hand, and will shortly be delivered.

PUMPING PLANT AT ST. JOHN'S COLLIERY, NORMANTON.

Pumps delivering 39 gallons per minute through a head of 530 feet = 6.3 H.P. in the water.

Work Done.	Speed of Engine.	Volts on Dynamo.	Average amps. given out by Dynamo.	E.H.P. given out by Dynamo.	Work done in Cylinder of Engine.	Efficiency per cent.	Loss in Cables res. 29 ohms 800 yards 19/16.
Pumps delivering 39 gallons per minute.	86	171 173.5	47.5 47.5	10.9 11	14.2 H.P.	44.4	.88 H.P.
Pumps running with the suction clack lids off and the column empty.	86	134 128 127	28 28 26	5 4.82 4.45	6.3 H.P.	..	.305 H.P. .305 H.P. .265 H.P.
Motor and first motion shaft only.	88 86	111 105	20 20	2.96 2.8	4.8 H.P.	..	.156 H.P.
Dynamo only, running on open circuit.	86	0	0	0	1.715 H.P.	..	0

UNITED STATES NAVAL PROGRESS.

REPORTS recently made to the Navy Department indicate the progress made so far in the work on the new warships.

THE NEW SHIPS.

At Cramps' Sons, Philadelphia, the gunboat *Yorktown* is about ready for launching, and the dynamite gunboat will be ready in March. The boilers for the *Yorktown* are finished and the engines are well advanced. The cruiser *Baltimore* has about all of her frames up and plated. The decks are laid, and if material is forwarded from the iron mills it is probable that this vessel will be launched some time in April.

The *Newark* and the *Philadelphia* are making slow progress, the lack of material acting as a bar to rapid work. Material, however, for both of these ships is being received, and the work of construction will go on more freely as soon as some indispensable preliminaries are settled.

From Chester, Constructor Steele reports that work on the *Bennington* and the *Concord* is progressing favorably, but not as rapidly as could be desired. They are, by contract, to be completed by May, 1889, but it is thought that neither of them will be ready for the water at that date. The keels of both these gunboats will be laid by March 10.

The gunboat *Petrel*, under construction at Baltimore, is progressing slowly. This vessel was to have been practically completed by December 22, but it will be some time before the Government will be able to take any steps toward fitting her for sea. The Columbian Iron Works, contractors for this vessel, have made a formal application to the Secretary to be relieved from the penalties for failure to complete her within the contract time.

From New York, Assistant Constructor Hanscom reports that the preliminary work on the armored cruiser to be built at that navy-yard is in a fair state of forwardness. Her lines have already been laid off in the mould loft, and the blocks and platforms are in place for building the ship. Tools and general plant, as well as material, have already been contracted for, and as soon as the machine shop and store-house are completed, the various details will begin to assume shape. It is not probable, however, that much will be done in the way of actual construction before July or August next. The preliminary steps for the two gunboats to be constructed at New York are still in embryo, but the spring will probably see rapid progress in their

erection. The *Chicago*, having undergone a most successful power trial, is waiting for orders from Washington to be fully completed and fitted for sea. The *Boston* is practically completed, but has only a portion of her battery on board. It will, it is said, require additional appropriation to complete the ship, armed and equipped ready for sea. The *Boston* and the *Atlanta* are in commission, and the latter craft will probably sail for the West Indies as soon as the work found necessary on her bottom shall have been completed.

The armed cruiser in process of building at Norfolk Navy-yard, Va., is in pretty much the same condition as the similar vessel at the New York yard. Progress on both of these huge vessels will be necessarily slow.

These two ships, to be built at the New York and the Norfolk yards, will be the largest vessels in the Navy. They will be named the *Maine* and the *Texas*.

The *Charleston*, at San Francisco, is progressing very favorably, and were it not for the unexpected delay in the shipment of material from the East, the contractors for this vessel would be well abreast of the terms of the contract. As it is, the *Charleston* will be among the new ships to be finished long after the date specified in the contract.

The *San Francisco* is still in the future, as far as actual work is concerned, and it will be many months before she is launched.

From all the contractors the complaint comes that material is not supplied fast enough by the rolling mills.

THE PITTSBURGH CAST-STEEL GUN.

The accompanying sketch, from the *American Manufacturer*, shows the gun recently cast at the works of the Pittsburgh Steel Casting Company in Pittsburgh. The plain lines show the finished size of the gun; the dotted lines show the size of the casting, the portion above the breech being the sinking-head for feeding the shrinkage of the casting. The gun was cast in a vertical position, the muzzle end downward.

The total length of the casting over all was 276¾ in. The sinking-head, which was made in two diameters, is 72 in. long. The part immediately above the gun, which was 48 in. long, is 16½ in. in diameter at the top, and 17 in. at the breech, the smaller section, which is 2 ft. high, being 15 in. in diameter at the bottom and 14½ at the top. The finished length of the gun is 193.53 in.; the total weight of the metal, 18,490 lbs.; the length of the pattern for the gun proper, 204¾ in.

The mould, as stated above, stood on its end, in a pit dug for the purpose, its top rising about 6 ft. above the ground.

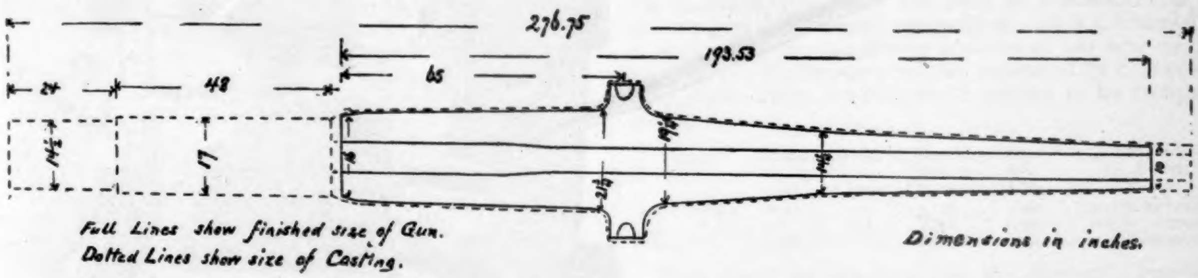
The casting, as well as the entire arrangements for the same, were under the personal direction of Mr. William Hainsworth, the General Superintendent of the works.

After being allowed to remain in the mould five days to cool, the gun was removed and carefully and thoroughly examined without showing the least flaw. It has since been put in the lathe and turned, on the outside, the small amount of reduction that is called for, still without developing any flaws, and the rough boring has begun. As soon as this is finished it will be shipped to the Navy-Yard at Washington, where it will be machine-finished, which must be done within four months after delivery by the contractor, while the statutory test of the gun must take place within three months after the completion of the machine finishing. This test is to consist of 10 rounds (the weight of the projectile and muzzle velocity being at least 100 lbs. and 2,000 foot-seconds respectively) fired as rapidly as the gun can be loaded by hand and discharged. The gun will be critically inspected after this test and the piece must not exhibit any defects or weakness.

Samples of the steel have been subjected to the following physical tests, which shows it to possess to a remarkable degree the qualities which theoretically are best adapted to withstand the strains which it will be called upon to endure. One of the test pieces taken from near the trunnion, and unforged, was given the usual tests for tensile strength, elastic limit and elongation, with results as follows: Ultimate strength, 92,700 lbs.; elastic limit, 51,960 lbs.; elongation in 2 in., 12½ per cent. Samples taken during casting, under cold bending tests, gave the following results: Pieces forged from 2-in. square ingot to ⅝-in. square, and allowed to cool, were bent cold to an angle of 161° without fracture. The other tests have been made from steel cut from the gate or runner, which was at one side of the gun. The runner, which was originally 2¾ in. in diameter, was turned down to 2 9/16 in., and cut into pieces 4½ in. long. These pieces were then drilled or bored out through the longitudinal axis with a 15/16-in. drill. This size was adopted because the ratio of the diameter of the hole through the center to the outside diameter is the same as the ratio of the bore of the gun to its outside diameter at the thickest part of the breech. A round conical wedge, 1 9/16 in. long, the ratio of its diameter to its length being 1.125 : 14.250, was driven into the 15/16-in. hole in these test pieces by blows from a steam-hammer, the weight of the hammer being 1,000 lbs., and the area of steam cylinder 122¾ in., steam pressure about 75 lbs., drop of the hammer 1 ft., giving about 10,000 foot-pounds at each blow. This wedge was driven in flush at the fourth blow. It was then forced out by means of an Olsen testing machine, requiring a force of 28,450 lbs. The test piece was not ruptured.

Another test of a different character, designed to show the great stiffness of this steel as compared with forged steel (39 carbon), was made. A piece of the runner 2¾ in. diameter and about 14 in. long, supported by small pieces of steel ⅝ in. square placed 12 in. apart on an anvil, was struck 21 blows with a 35-lb. sledge, without result. It was then placed under the steam hammer and given 18 blows, which caused it to deflect ¼ in., the last blow breaking it in two pieces.

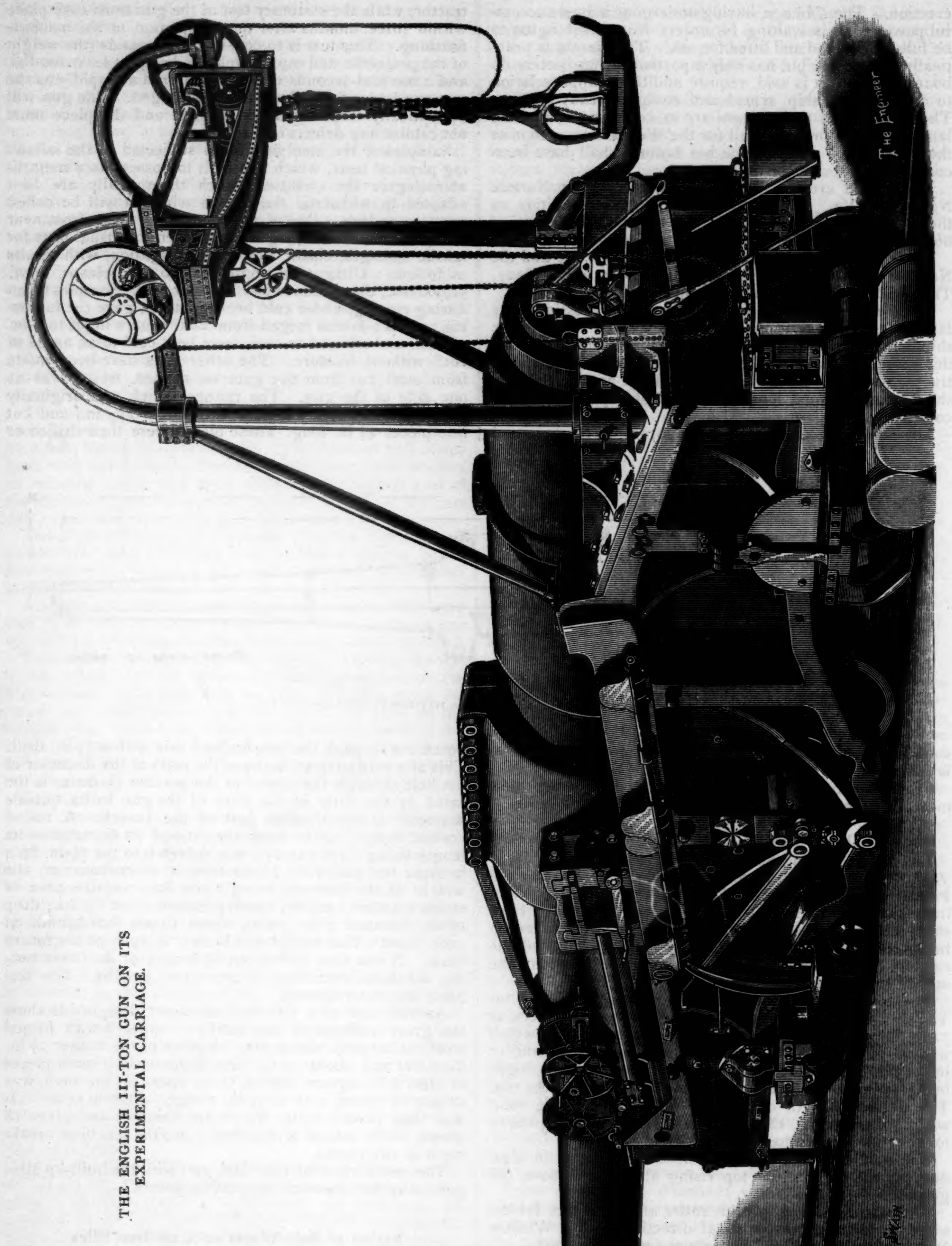
The comparison of this cast gun with the built-up steel guns may develop some interesting points.



STEEL GUN CAST FOR THE NAVY BY THE PITTSBURGH STEEL CASTING CO.

Action of Salt Water on Cast-Iron Piles.

SOME interesting experiments are reported by the *Indian Engineer*, which were recently made to test the condition of cast iron after a long period of exposure to salt water. These experiments were made by Mr. Hargrave, Resident Engineer of the Bombay, Baroda & Central India Railroad, and the special object was to ascertain whether there was any danger affecting the foundations of a number of bridges on the road, which rested upon piers formed by



THE ENGLISH 111-TON GUN ON ITS EXPERIMENTAL CARRIAGE.

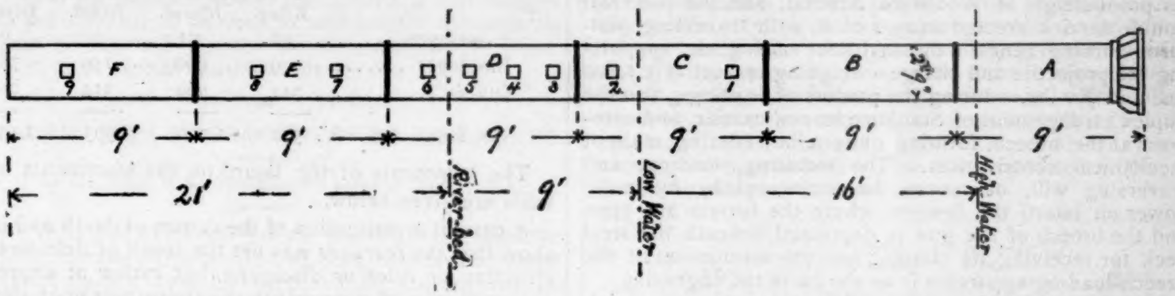
clusters of cast-iron columns. The particular column chosen for the experiment was one taken from pier No. 37 of the bridge at South Bassein, which spans a tidal estuary where the water is sea or salt water. This was one of the original columns, put in position in 1862, so that its age at the time of the test was 25 years. This column, as shown in the accompanying sketch, was made of joints 9 ft. in length, bolted together at the flanges. For convenience of reference each joint of the pile in the diagram is lettered and the test pieces which were cut out are numbered.

Specimens 9, cut from joint *F*, 8 and 7 from joint *E*, both of which were entirely below the river-bed, showed no corrosion whatever. Of those cut from joint *D*, which was partly in and partly above the river-bed, specimen 6 showed no corrosion; while Nos. 5, 4, and 3 were slightly corroded, but the greatest depth of this corrosion measured did not exceed $\frac{3}{32}$ in. This greatest corrosion was shown in No. 3, which is near the low-water mark, and about the same amount was shown in No. 2 in joint *C*, which was also near the low-water mark. The upper joints *B* and *A*, which were under water only at high tide, and thus were part of the time exposed to the action of the salt water and part of the time to the air, showed no corrosion whatever.

As to the bolts by which the joints of the pier were held together, the inside bolts were in good condition, while the bolts on the outside showed so little action from the water that they might be considered as good as when put in.

Engineer Hargrave says, in concluding his report:

"The lesson to be learned from this experiment is that the greatest corrosion in the piles exists close to low-water and does not extend to any considerable depth underneath it; the same has been observed in the case of the bolts and bracings. If this column can be taken as representing the average condition of the remainder of the columns in this bridge, we are in a position to state that, after a period of 25 years, our pile columns in a salt waterway are in a very good condition, and that the piles, where corrosion has been found, are in a position which can be easily got at for examination or renewal. This experiment further sets at rest all groundless fears as to the speedy deterioration of our pile columns from the action of sea water. The specimens have been put up in a neat case, which should be kept for future reference—when possibly 25 years hence another column may be examined and the results compared."



THE ENGLISH 111-TON GUN.

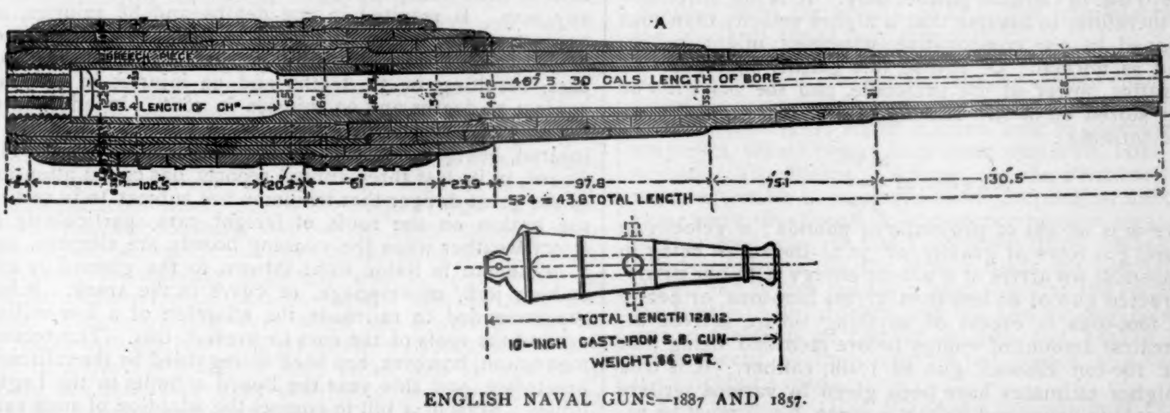
(From the London *Engineer*.)

Now that the *Benbow* is approaching completion in every respect, and about to be brought round from Chatham to Portsmouth for a trial of her great 111-ton guns, it is not an inappropriate time to say a few words in regard to the power and value of her armament, far surpassing—as it does—that of any ironclad afloat, whether in the navy of Great Britain or in that of any foreign power. The accompanying table will show in a moment that the 111-ton gun distances all competitors. In it a comparison is drawn between the salient features of our new weapon and those of the heaviest natures possessed by France and Italy, these being the only rivals worthy to be compared with it:

Country.	Caliber. Ins.	Weight. Tons.	Muzzle-velocity. Foot-secs.	Projectile. Lbs.	Penetrative Power.
Great Britain..	16.25	111	2,128	1,800	32.5 in. at 1,000 yds.
Italy.......	17	104	2,018	1,799	32.3 in. at muzzle.
France.......	14.66	71	1,955	1,180	27.3 in. at muzzle.

Thus it will be observed that the *Benbow's* gun has a greater penetrative power at 1,000 yards' distance from the muzzle than the Italian gun, its most formidable competitor, has at the muzzle itself. This would appear to be conclusive.

Before giving a brief description of the construction and parts of the new gun—drawings of which we give—we cannot refrain from remarking upon the prodigious strides which have been made in the development of gunnery science since the period of our last great war, both as regards the dimensions of the weapons employed and the complex nature of the machinery by which they are loaded and fired. A glance at the sketches given herewith, which give the relative sizes of the modern 111-ton steel rifled breech-loading gun and the old 10-in. cast-iron smooth-bore gun of a past age—drawn to the same scale—will exhibit at once the extraordinary rapidity of that development as far as regards proportions. It must be borne in mind that at the close of the Crimean War—only 30 years ago—the 10-in. smooth-bore gun was the heaviest and most powerful piece of ordnance that Great Britain possessed,



ENGLISH NAVAL GUNS—1887 AND 1857.

and we were then far ahead of all other nations in respect of armament. Yet in the present day the projectile and battering charge only of our most formidable weapon, taken collectively, actually bear an appreciable proportion to the entire bulk of the gun, which was considered monstrous in 1857, computing to one-third of it in weight. The complicated nature of the machinery required to load, fire, and control the new gun can be seen by a reference to the large engraving. It shows the gun mounted upon its proof-sleigh at Woolwich Arsenal, and the powerful double derrick erected in rear of it, with traversing platform working beneath the davits for raising and supporting the projectile and charge—weighing respectively 1,800 lbs. and 960 lbs.—during the process of loading; also the duplex arrangement of Stanhope levers, carrier, and cam-lever at the breech, forming quite a bewildering maze of mechanical contrivances. The elevating, loading, and traversing will, of course, be performed by hydraulic power on board the *Benbow*, where the turrets are open and the breech of the gun is depressed beneath the steel deck for receiving its charge; but the mechanism of the breech-loading apparatus is as shown in the engraving.

The principal dimensions of the 111-ton gun are as follows: Total length, including breech gear, etc., about 45 ft.; extreme diameter, 65.5 in.; caliber, 16.25 in.; length of bore, 487.5 in., or about 30 caliber; diameter of powder chamber, 21.25 in.; capacity of same, 28.610 cubic inches; the charge is 960 lbs. of what is called experimental slow powder, of hexagonal shape, with a hole through the center, and almost analogous in its character to the well-known prismatic No. 1 brown, of which most of the charges for many breech-loading guns are now made up. The building up of these charges is most curious. It is like a child's puzzle-map. A plan is drawn of the exact number of hexagons that will most nearly cover a space equal to the base of the charge. Rows and rows are then placed upon the first layer, always leaving the central holes clear above one another for the flash to communicate with the whole mass, as the sides fit exactly. The mass when made up fits into a stout silk bag, and after being "choked" is put into a long metal cylinder for conveyance on board ship; 560 of such cartridges form the "unit" for the *Benbow* in peace time.

An initial velocity of 2,143 foot-seconds was actually obtained on March 28 last at the proof butts, Woolwich Arsenal, with the second of the 111-ton guns. This was with 850 lbs. of German powder only. It is not unreasonable, therefore, to assume that a higher velocity than that mentioned in our comparative statement might be regarded as normal. Of course this greatly increases the penetrative power of the projectile, and the *vis viva* or energy stored up in it. Making use of the generally accepted formula:

$$vis\ viva = \frac{w\,v^2}{2\,g}$$

(where w is weight of projectile in pounds; v velocity in feet, and g= force of gravity, or 32.2—the result being in foot-pounds) we arrive at a muzzle energy with our newly-constructed gun of no less than 57,304 foot-tons, or nearly 5,000 foot-tons in excess of anything before arrived at, the greatest amount of energy before recorded being that of the 100-ton Elswick gun of 17-in. caliber. It is true that higher estimates have been given by various writers of the energy developed by this weapon, but it must be remembered that they were conjectural. Lord Brassey gives it in a table as 61,200 foot-tons. As, however, in order to produce this abnormal energy he quotes a muzzle velocity of 2,214 foot-seconds, which has not been obtained during the Government trials at the Woolwich butts, the figures resulting from these velocities are misleading and untrustworthy. Be it as it may, however, the 111-ton gun stands unrivaled among its compeers, and the *Benbow*, the *Sans Pareil*, and the *Victoria* will have by far the most powerful armament afloat in all the navies of the world. We only regret one circumstance connected with the mounting of these guns; it is that they should be so entirely exposed above the open turrets. This, however, is a defect of the *Admiral* class construction which cannot, we fear, be remedied.

RAILROAD ACCIDENTS IN NEW YORK.

THE report of the New York Railroad Commission for the year ending September 30 last gives a tabular statement of all the accidents to persons, and their causes, reported for the years 1887 and 1886. This table, condensed, gives the total number of casualties as follows:

	1887.		1886.	
	Killed.	Injured.	Killed.	Injured.
Passengers	22	91	30	95
Employés	199	900	159	788
Others	311	269	314	255
Total	532	1,260	503	1,138

The comments of the Board on the statements in this table are given below.

A careful investigation of the causes of death and injury show that the *increase* was not the result of defective construction or rules or discipline, but rather of unpreventable causes or of misconduct or carelessness upon the part of those killed or injured. While during the year ending September 30, 1886, 19 passengers were killed and 52 injured *from causes beyond their own control*, during the last year but 2 were killed and 35 injured from such causes. By their own misconduct or want of caution, however, 16 were killed and 50 injured in 1887, as against 9 killed and 31 injured in 1886. The same is true with regard to employés: 9 were killed and 72 injured from causes beyond their own control in 1887, as against 25 killed and 149 injured in 1886. The increase in the total number of people killed in 1887, as compared with 1886, is due to the fact that 102 employés were killed while walking or being on track in 1887, as against 51 killed the same way in 1886.

The principal cause of death and injury to passengers was getting on or off trains in motion—7 out of a total of 22 killed, and 31 out of a total of 91 injured. This was the fourth cause leading to death to employés, having caused 9 deaths and 28 injuries. Greater care should be observed by both passengers and employés in regard to this matter.

The most serious cause of death to employés, as in 1886, was walking or being on the track, a danger incident to their occupation, and probably not preventable in any way. It resulted in 102 deaths and 88 injuries, as against 51 deaths and 59 injuries in 1886. The next cause of death and injury was falling from trains, engines, or cars, resulting in 37 deaths and 99 injuries in 1887, as against 30 deaths and 93 injuries in 1886. In addition to the employés thus killed, there were 3 others killed and 9 injured, being trespassers engaged in stealing rides. The Board, in its last three annual reports, has called attention to the great danger that trainmen are subject to in setting the brakes on the roofs of freight cars, particularly in frosty weather when the running boards are slippery, and a brakeman is liable to be thrown to the ground by any sudden jerk, or stoppage, or curve in the track. It has recommended to railroads the adoption of a low railing around the roofs of the cars to prevent this. The recommendation, however, has been disregarded by the railroads heretofore, and this year the Board submits to the Legislature a draft of a bill to compel the adoption of such railings, to which your attention is especially directed. Should a continuous air-brake be adopted by railroads generally, it will do much to diminish this cause of mortality to employés.

The cause leading to the third greatest number of deaths, and to injuries equal in number to all other causes, was coupling or uncoupling cars. This resulted in 20 deaths and 437 injuries, as against 23 deaths and 365 injuries in 1886. It is to be hoped that the general adoption of the automatic coupler hereafter alluded to will, before long, materially diminish this serious cause of death and injury.

The most serious cause of death to others not employés or passengers was walking or being on the track, having caused the death of 233 and injury of 124, as against the death of 247 and injury to 111 in 1886.

The next cause of death to others was being run over at highway crossings. This resulted in the death of 42 and injury to 57, as against the death of 28 and injury to 43 in 1886. Of the killed, 12 were at crossings protected with gates or flagmen, and 9 injured at such crossings. This subject is further discussed under the head of legislation.

While a great improvement has been accomplished within the last four or five years in the maintenance and construction of railroads, in the adoption of uniform rules and signals, in the improvement in the construction of bridges, much yet remains to be done to still further diminish the dangers of railroad travel. To this subject the Board gives its most careful consideration.

ACCIDENTS ON MASSACHUSETTS RAILROADS.

(From the Report of the Massachusetts Railroad Commission.)

THE record of accidents for the year ending September 30, 1887, is even more lamentable than that of the preceding year, though that far exceeded the average in the number of casualties. Ten collisions and 8 derailments caused the death of 28 persons and injured nearly 200. These accidents were investigated by the Board.

The whole number of persons injured (as reported to the Board at the time the accidents occurred) was 802, an increase of 211 over last year, due in a great measure to the Bussey Bridge disaster. Of these, 198 were passengers, 357 were employés, 54 were travelers at highway crossings and persons lawfully at stations, and 193 were trespassers, who were unlawfully on the track or stealing rides on freight trains. The number of passengers killed or injured was larger than last year by 84, and there were 83 more casualties to employés, an increase of more than 73 per cent. in passengers and 30 per cent. in employés. There were 10 more persons killed or injured at grade crossings and stations, and 34 more trespassers suffered the penalty of their offense.

Of passengers 23 were killed and 121 were injured by causes beyond their own control, while 14 were killed and 40 were injured through their own misconduct or want of caution, a slight decrease in the total casualties of this class from the preceding year. There is a discrepancy in the number of passengers injured in the Bussey Bridge disaster as returned at the time of the accident and the number reported in the annual return of the Boston & Providence Railroad. The number first reported was 100, but by the annual return the number known and claiming to have been injured was more than 200. A large part of this excess is probably made up of indefinite, uncertain, and perhaps imaginary injuries.

Of the casualties to employés, 79 were fatal and 278 were not fatal. Eleven were killed and 111 were injured when coupling or uncoupling freight cars. Eight of these accidents occurred where one of the couplers was an authorized automatic coupler, one where both couplers were authorized automatic couplers of the same kind, and five occurred in coupling passenger cars equipped with the Miller hook to freight cars having the link-and-pin drawbar. Four employés were killed and 6 were injured by contact with overhead bridges or other structures less than 18 ft. above the track; 6 were killed and 26 injured by train accidents; 24 were killed and 50 were injured by falling from trains; and 34 were killed and 85 were injured by accidents from a great variety of causes. Most of them were due to crossing or standing on tracks or incautiously stepping in front of a moving engine or car in railroad yards, or jumping from moving trains.

At grade crossings of highways protected by gates or flagmen there were 17 casualties, and at crossings without gates or flag there were 30; of these 19 were fatal and 28 not fatal. This is a decrease of 3 fatal accidents and an increase of 15 not fatal. Three persons were killed and 4 were injured when imprudently crossing the tracks at stations.

Trespassers, as usual, furnish the largest number of fatal casualties, 126 having been killed, while 67 were injured not fatally. Last year 91 were killed and 68 were injured. Of the trespassers killed, 11 are reported as apparently suicides. Twenty-six were reported as intoxicated at the time of the accident, and it is not improbable that others who were killed while lying on the track were in a like condition.

It appears also from the reports that eight of the passengers killed or injured through their own imprudence were under the influence of liquor.

If all the companies adopted the same rule in reporting accidents, there is a great difference in the number of actual casualties on the several roads in proportion to their traffic. In the case of passengers killed and injured through their own fault there are no sufficient data on which to base a comparison, as we do not know the number of passengers carried in Massachusetts. The following table shows the ratio of passengers injured to the miles operated in Massachusetts; but as some roads carry more passengers than others on the miles operated within the State, the comparison is not accurate.

RAILROADS.	Miles Operated in Massachusetts.	Passengers Injured by their Own Fault.	Ratio.
Boston & Albany..........	332	7	1 to 47 miles.
Boston & Lowell............	131	5	1 to 38 "
Boston & Maine............	262	16	1 to 17 "
Boston & Providence	57	2	1 to 28 "
Fitchburg....................	227	12	1 to 19 "
New York & New England.	109	1	1 to 109 "
Old Colony..................	460	7	1 to 65 "
Four Southern Roads......	958	17	1 to 56+ miles.
Three Northern Roads.....	680	33	1 to 20+ "

The Old Colony Railroad, being almost wholly within the State, affords the fairest ratio of passengers injured to miles operated. It will be seen that the proportion of such accidents to miles operated is much less on the four roads entering the city of Boston on the south side than on those entering on the north side.

This is also true in comparing these casualties with the total number of passengers carried—being 1 to 1,920,881 on the south-side roads, and 1 to 933,002 on the north-side roads. The ratio would be still more favorable to the south-side roads on the basis of total passengers carried within the State on the several roads. The question arises whether the passengers on the south-side roads are more careful than those on the north-side roads, or are better guarded from the results of their own imprudence—or if the accidents are as fully reported.

There is a similar difference in the reported accidents to employés, and it is evident that the several roads do not adopt the same rule as to what casualties shall be reported. While some report slight injuries both to passengers and employés, others report only those which are fatal or very serious. The Boston & Albany and the Fitchburg report many accidents to employés while coupling or uncoupling cars, while the Boston & Providence reports no accidents of that kind, and the Old Colony but three. Many of the injuries reported by the former roads are comparatively slight, and it does not seem probable that the employés of the Boston & Providence and the Old Colony escape the minor accidents of bruised thumbs and broken fingers which occur so frequently on the Boston & Albany and the Fitchburg roads.

The following table shows the proportion of employés killed and injured to the whole number on the several roads terminating in Boston:

RAILROADS.	Total Number of Employés.	Number Killed and Injured.	Ratio	Per Cent.
Boston & Albany..	5,698	96	1 in 59	.017
Boston & Lowell............	4,066	41	1 in 98	.010
Boston & Maine.......	5,017	33	1 in 152	.006
Boston & Providence.......	1,011	5	1 in 202	.004
Fitchburg....................	3,324	82	1 in 40	.024
New York & New England	3,189	50	1 in 63	.015
Old Colony...	3,517	17	1 in 207	.005

The last railroad year makes an unfortunate comparative showing in accidents to passengers from causes be-

yond their own control. The proportion of killed and injured to the total number of passengers carried was: Killed, 1 in 3,605,363; injured, 1 in 685,317. This is, with one exception, the highest ratio for any year on the last decade, as shown by the following table:

PASSENGERS KILLED AND INJURED FROM CAUSES BEYOND THEIR OWN CONTROL.

YEAR.	Killed.	Injured.
1878	0 in 37,318,427	1 in 18,659,213
1879	1 in 2,246,522	1 in 232,057
1880	1 in 45,151,152	0 in 45,151.152
1881	1 in 12,458,622	1 in 7,119,213
1882	1 in 55,868,694	1 in 18,622,898
1883	0 in 61,530,747	1 in 2,563,781
1884	1 in 3,482,952	1 in 1,160,984
1885	0 in 69,603,700	1 in 5,800,308
1886	1 in 7,584,258	1 in 2,166,931
1887	1 in 3,605,363	1 in 685.317

None of these tables, however, are satisfactory for purposes of comparison, because, while the number of accidents given include only those in Massachusetts, the number of passengers carried includes all carried outside of, as well as within, the State; and the number of employés includes all employed on the whole length of the roads operated by the several companies. . . . . .

It is important that this Board should be notified at once, by telegraph or telephone, of any serious train accident. The examination of the wreck before it has been disturbed renders the investigation into the causes of the accident much less difficult. It is true that the wreck may be burned, and that in many cases, even when notice is given immediately, it will be necessary, before any member of the Board can arrive on the scene, to clear away the wreck for the passage of trains, to replace sleepers, frogs, and rails, and perhaps break up shattered cars so as to get them out of the way, and that important features may thus be lost sight of. It should be made the duty of some official, after attending to the wounded, to make a rough diagram of the wreck, showing the locations of the different parts of it with reference to each other and surrounding objects, such as trees, rocks, telegraph poles, houses, etc.; and also a brief, general description of the condition of its different portions.

Great assistance in investigating the causes and details of the Bussey Bridge disaster was rendered by the numerous photographs which were taken. Amateur photography is now so common, and the process so simple, that it seems not unreasonable to request that railroads, in connection with their wrecking apparatus, should have a photographing outfit, and that they should, when possible, cause photographs to be taken of the wreck from several points of view, so that the exact position of it with reference to surrounding objects, and the condition and position of the cars, bridge or other débris, may be clearly shown. No legislation upon this subject is necessary, as the railroads will undoubtedly comply with the expressed wish of the Board.

Formulæ for the Resistance of Iron and Steel.

(Note by M. Bricka in *Annales des Ponts et Chaussees.*)

THE attention of engineers in France has been for some time called to the experiments of Wöhler and Spangenberg relative to modifications undergone by the resistance of metals when they are submitted to repeated strains.

M. Considère has analyzed these experiments in his paper on the use of iron and steel in construction, published in the *Annales* for April, 1885; M. Sejourné, Engineer of bridges and roads, has made them the subject of a note which is known to many of our associates; M. Flamand has referred to them in his report of the commission on the resistance of steel; M. Mayer has published recently (*Annales* for December, 1886) a very interesting account of the last work of Bauschinger, who continued the work of Wöhler and Spangenberg; finally, we have had occasion in a paper on Metallic Bridges, in the *Annales* for March, 1887, to cite the formulæ of Launhardt and Weyrauch,* which are deduced from the laws of Wöhler, and which are now generally employed in Germany.

These formulæ of Launhardt and Weyrauch were some years ago, I believe in 1881, the subject of a very interesting discussion in the Society of Engineers, in which MM. Tresca, de Comberousse, and other eminent engineers took part. In this discussion some of the speakers brought up the point of how much the experiments of Wöhler and Spangenberg, in which the strains were repeated at extremely small intervals, differed from the conditions realized in actual practice, in relation to different parts of iron structures; and here we should remember that these experiments were made with the view of studying the work of metal in the wheels of cars and not in bridge girders. It was also remarked in this discussion that, at least when the strains were of the same kind, their indefinite repetition was found to be without danger so long as the limit of elasticity is not reached. The engineers who had taken part in this discussion were especially almost unanimous in setting aside the principle which served as the basis of the formulæ of Launhardt and Weyrauch, which makes the coefficients of resistance rest upon the consideration of the limit of the breaking strain.

The discussion of the experiments of Bauschinger shows incontestably the justice of the observations made to the Civil Engineers' Society. These experiments have proved, in fact, that the length of the interval of time between the application of successive strains may be neglected; and that a test piece may be submitted to strains repeated several million times without causing modifications either in its structure or in its resistance to statical strains.

The results found by this experimenter, so far as relates to variations to which the limit of elasticity is subject, under certain conditions, serve, moreover, to confirm the justice of the principle adopted by French engineers, who hold that the stability of the structure is no longer assured when this limit is passed.

To recognize how hazardous the application of the laws of Wöhler to constructions in metal is, it is not necessary, in our opinion, to study experiments made, like those of Bauschinger, with readings to two-thousandth of a millimeter. The variations to which the limit of elasticity is subject under strains which reach this limit were long since known in France from the very simple experiments of M. Tresca. As to the invariability of structure and of resistance to breaking of iron or steel submitted to such strains as those carried by metallic bridges, it is easy to verify that by experiments on the rails of a railroad track. These rails are, from the point of view of the influence of constantly changing strains, placed under the most unfavorable conditions; their weight in the interval comprised between two successive shocks may be absolutely neglected in comparison with the variable loads, which always exceed one ton for the wheels of the cars, and which sometimes reach as high as seven tons for the wheels of the locomotive; the rails receive these shocks directly, without the interposition of any elastic material; frequently the metal is subjected alternately to strains of tension and compression according to the position of the wheels. On the other hand, these strains reach a very high limit under the passage of locomotives.

In the track of the Orleans and of the State Railroad,

* The formula of Launhardt is as follows for iron:

$$R = 800\left(1 + 1\,\frac{S\ \text{min.}}{S\ \text{max.}}\right)$$

For steel:

$$R = 1200\left(1 + \tfrac{9}{8}\,\frac{S\ \text{min.}}{S\ \text{max.}}\right)$$

For pieces in which the strain is always in the same direction.
The formula of Weyrauch is as follows for iron:

$$R = 700\left(1 - \tfrac{1}{2}\,\frac{S\ \text{min.}}{S\ \text{max.}}\right)$$

For steel:

$$R = 1100\left(1 - \tfrac{5}{11}\,\frac{S\ \text{min.}}{S\ \text{max.}}\right)$$

For pieces in which the direction of the strain varies.
In all these formulæ S min. and S max. indicate in absolute value the smallest and the greatest strains to which the pieces calculated can be subjected.

one of the best which exists in France, the tension and the compression per square millimeter, supposing that all the ties are uniformly tamped, are not less than $8\frac{1}{2}$ kilos. when the rail has not had much wear;* they increase to 13 kilos. when the two rail-heads have had each a wear of one centimeter. Now, it frequently happens that ties badly supported yield under the pressure of the wheels, and the derangement thus produced by the loss of one of the points of support increases in considerable proportion the work of the metal. Under these conditions, if we take into account the numerous causes of weakness to which rails are subjected up to the moment when their renewal becomes necessary (diminution of the section of the metal in consequence of wear; play of the chairs; weakness of the fastenings; depreciation of the quality and the quantity of the ballast), we are astonished that the number of breakages is not greater, and we can confidently affirm that it would be very much greater if the variation of the strains to which the metal is subjected produced any sensible alternation in its constitution.

It would be easy to assure ourselves that rails do not change, by means of trials made on steel rails which have arrived at the limit of wear of lines of heavy traffic; we might admit that, up to the time when they are taken out of the track, they have been subjected to the passage of not less than 200,000,000 tons, which, if we assume an average load of five tons per axle, corresponds to the repetition of the strain 40,000,000 times. We have not had at our disposal rails under these conditions, but we have been able, thanks to the kindness of M. Planché, Director of the forges of St. Nazaire, to test some pieces of iron rails which had been for 20 years in the main track of the lines from Saintes to Angouleme, from Nantes to La Roche-sur-Yon, and from Niort to La Poussoniere, and which had supported the passage of about 1,200,000 axles. These tests have given on the four samples a resistance to tension of 31, 35, 37, and 39 kilos. to the square millimeter, and limits of elasticity exceeding $22\frac{1}{2}$ kilos. Now, we can see that at the end of 20 years and after the passage of over 1,200,000 axles, the iron of rails exposed to strains which very often exceed 8 kilos. to the square centimeter is still, from the point of view of resistance, equivalent to metal of the first quality. From this we can certainly conclude that in any structure where the action of accidental strains is exercised under conditions infinitely more favorable it will not produce, even after a very considerable number of repetitions, any injurious effect.

The extension to metallic bridges of the results of the experiments of Wöhler and Spangenberg is, then, in our opinion, condemned as much by the results of the experiments of Bauschinger as by the observation of facts; nevertheless it does not follow that we should reject purely and simply the formulæ based upon these experiments. If we look only from the point of view of the coefficients of work to which it leads us in different cases, the formula of Launhardt (we do not speak here of the formula of Sejourné, which appears to us preferable to that of Launhardt, the discussion of the formulæ themselves not entering into the purpose of this paper) only expresses the rule now adopted in France, by which the limit of the work of metal is made lower as the accidental strains become relatively greater. Now this rule is evidently justified as much by the dynamic effects which these strains can produce as by the impossibility of determining the maximum value, especially in works intended to last a long time.

As to the formula of Weyrauch, which tends to reduce in large proportion the maximum coefficient of work when parts are exposed to frequent reversal of strains, it appears to us, even after the experiments of Bauschinger, to rest only upon assumptions altogether insufficient; and we have the right to conclude from the behavior of rails that it leads in all cases to coefficients reduced much beyond the limit required by prudence.

Whatever opinion we may have as to the value of the formulæ of which we have spoken, there is in all these cases an element which should not be neglected in the study of metallic bridges; it is the constitution of the girders themselves which we have to calculate. The hypotheses which have been made on the question of the repetition of strains in the parts are often so far removed from the truth that the coefficient of work of the metal to be adopted in calculations cannot safely be determined without taking account of this constitution.

* This calculation is made by assuming that the rail rests on six ties for a length of $5\frac{1}{2}$ meters (18 ft.), or 12 for a length of 11 meters (36 ft.); the Orleans Company increases the number of ties one-sixth on its lines of heaviest traffic, but this change is made much more for the purpose of increasing the bearing and steadiness of the track than for diminishing the strain on the rails.

A Great Indian Bridge.

(From the *Indian Engineering*.)

THE bridge over the River Ganges at Benares, lately completed by the Oude & Rohilkund Railroad Company, forms a most important link between the railroads in Oude and the Northwestern Provinces and the East Indian Railway. It brings Lucknow in direct railroad communication with Calcutta by a route 52 miles shorter than that *via* Cawnpore.

The junction with the East Indian Railroad at Mogul Serai will give the nearest route to the Punjab *via* the Oude & Rohilkund Railroad Company's new Northern Extension joining in with the Northwestern Railway at Saharunpore.

The bridge consists of 16 spans, viz., seven of 356 ft. and nine of 114 ft., measuring from center to center of piers. The larger spans extend from the north bank over the river, and the smaller spans are flood openings in case of overflow of the river on the south bank. The total length of the bridge from end to end of girders is 3,523 ft. The piers of the larger spans are founded on elliptical wells 65 ft. by 28 ft.

The piers of the smaller spans are each founded on two circular wells 12 ft. 6 in. in diameter, pitched 25 ft. center to center, and varying in depth from 63 to 152 ft. below ground level.

Both abutments are founded without well foundations—that at the south end having long wing-walls giving access to the bridge by a flight of steps on each side. On these abutments block-houses will be constructed for the military defence of the bridge.

The weight of the material used in one of the deep piers is about 16,000 tons. This enormous weight has, with the exception of the iron caisson and stone cap, been carried into place on coolies' heads along a narrow floating staging leading to each pier.

The girders are lattice built and are entirely of steel, the total weight of steel used in the 16 spans being 6,405 tons.

The girders were supplied by the Patent Shaft & Axletree Company, Wednesbury, England.

The main spans are the longest yet constructed in India, without the use of the cantilever form of girders, and the foundations of some of the main piers are the deepest in the world, being in some cases 140 ft. below water level.

The girders of the main span are 35 ft. in depth and 25 ft. apart, center to center. The traffic is carried between the girders of the main span and on top of the girders of the smaller spans, the road and the rail being of the same level, with footways on either side on cantilevers outside the main girders.

The girders of the smaller spans were utilized for erecting the main girders. Their length being one-third that of the main girders, it required three of the smaller girders to carry one of the larger, and therefore by erecting two temporary piers, one of the main openings was spanned by three smaller girders.

Work was carried on by day and night except during the very cold weather. The Gulcher system of electric lighting was in use, and worked most satisfactorily. It may be confidently stated, that without the assistance of electric light the bridge would not have been built, simply because it would be impossible without continuous night-work during the busy time to get through such work as must be completed to render the structure safe from flood during each season.

The first brick of this bridge was laid January 19, 1882, and it was ready for traffic in October, 1887.

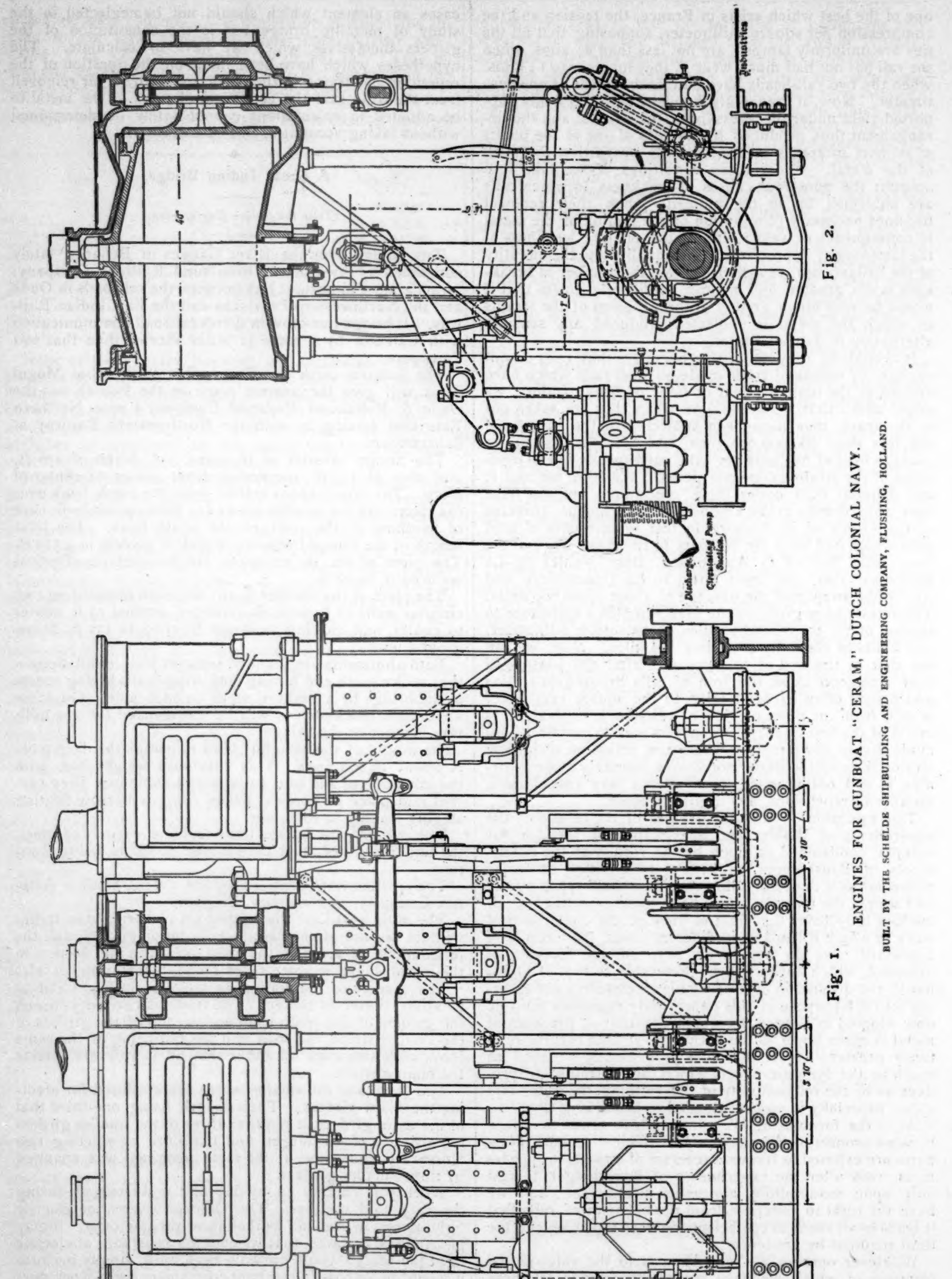


Fig. 1. ENGINES FOR GUNBOAT "CERAM," DUTCH COLONIAL NAVY.

BUILT BY THE SCHELDE SHIPBUILDING AND ENGINEERING COMPANY, FLUSHING, HOLLAND.

Fig. 2.

Engines of a New Dutch Gunboat.

THE accompanying illustrations (from *Industries*) show the engines and boilers of the new gunboat *Ceram*, recently built for the Dutch Colonial Navy by the Schelde Shipbuilding & Engineering Company at Flushing, Holland, Mr. W. H. Martin being the Engineer.

The engines are of the triple-expansion surface-condensing type, the cylinders being 20 in., 29 in., and 46 in. in diameter, and the stroke 29 in. The high-pressure cylinder is fitted with a liner of Whitworth compressed steel ½ in. thick, the space between the body of the cylinder and the liner being utilized for jacketing. The pistons are of cast steel, with junk rings of the same material, and fitted with Buckley's piston rings of much lighter section than usual. The slide valve of the high-pressure cylinder is cylindrical, and is made in that form for the purpose of bringing the inlet steam to the center of the valve. The intermediate and low-pressure valves are flat, but work under a strong cover, with false ports, for relieving them of the steam pressure. The valve arrangement consists of Bremme's gear, with the eccentrics on the couplings of the crank shaft. The vertical rods of the gear are connected by a ball joint to a floating lever, which actuates the three valves. For reversing the engines a reversing engine is used having a 7-in. steam cylinder, with 19-in. stroke, cast in one piece with the intermediate cylinder, and placed between this and the high-pressure cylinder. The piston rod of the reversing engine actuates, by means of a small connecting rod, a lever on the reversing shaft. The valve of the reversing cylinder is moved by a rod fixed to a hand lever, turning round a small eccentric on the reversing shaft, so that the valve is closed by a movement of the reversing shaft, equivalent to that given to the reversing handle. The reversing of the engines from full speed ahead to full speed astern is brought about in two seconds. The reversing shaft is carried in a pipe cast in one piece with the guide of the high-pressure cross-head. It will be seen from the illustrations that the pin forming the cross-head is attached by two bolts to the connecting rod. In this arrangement, the piston-rod ends are solid and without any cover, so that the brasses can be easily adjusted to the pin with the connecting rod disconnected. The brasses are closed up by a wedge worked by a screw from the front of the piston rod, this position being much more convenient than that of the nuts of the ordinary cover. The piston, connecting rods, and the crank shaft are made of steel, the latter being made in three equal parts. The corners of the crank webs are cut off, as shown, in order to reduce the weight. The bed-plate is made entirely of cast steel, and as light as possible while maintaining the necessary strength and rigidity; the total weight being only two tons. The foundation in the ship is formed by heightening the frames, and bending them into such a shape as to fit the bed-plate. The shaft brasses have no flanges, but are kept in place by pins fitting into holes bored in the bed-plate and cover. The eccentrics on the couplings are also without flanges, so as to leave the eccentrics free to move forward and backward with the shaft without bearing against the eccentric rings. The air and circulating pumps are single acting and cast in one piece. They are made of brass, while the feed and bilge pumps are of gun metal.

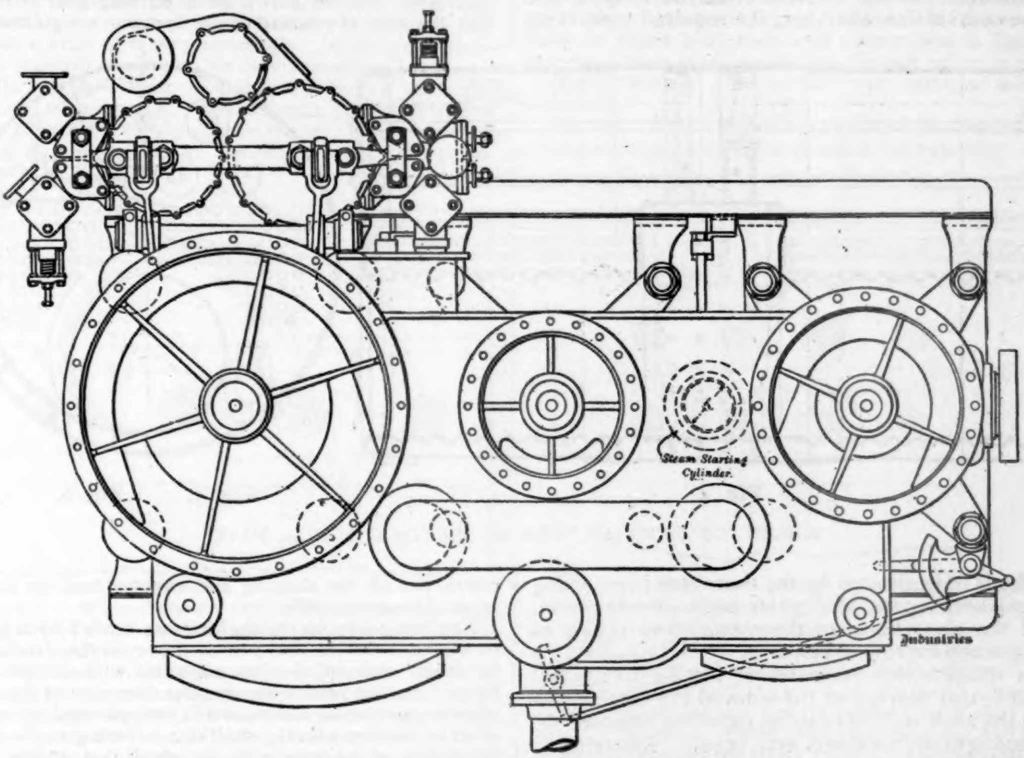


Fig. 3.

ENGINES FOR GUNBOAT "CERAM."

The columns supporting the cylinders consist of drawn-steel tubes 3 in. external diameter and ⅜ in. thick; but turned out of tubes ⅝ in. thick, to get the necessary thickness in places where holes had to be bored through them. At the ends where they fit into the bosses on the cylinders and bed-plate, they are forged to a smaller diameter, giving greater thickness of metal where the thread is cut. The condenser is made entirely of copper, the shell having corrugations at intervals, instead of the rings usually riveted on to it, to strengthen it against collapse; and the covers have radial corrugations for the same reason. Condensers made on this system are light, and have the additional advantage of having no rivet holes.

In the accompanying illustrations fig. 1 shows a front elevation of the engine (with section of the high-pressure cylinder); fig. 2 an end elevation (with section of the low-pressure cylinder), and fig. 3 a plan.

Steam is furnished by two double-ended boilers, 8 ft. 2 in. outside diameter and 15 ft. long, with one corrugated furnace 3 ft. 3 in. mean diameter. Each of these boilers

has 160 tubes $2\frac{5}{8}$ in. external diameter, and 40 stay-tubes $2\frac{3}{4}$ in. diameter and $\frac{1}{4}$ in. thick. Figs. 4. 5, and 6 show one of these boilers, fig. 4 being a longitudinal section, fig. 5 a half end-view, and fig. 6 a half cross-section.

The working pressure was fixed at 120 lbs. by the naval authorities, as, at the time when these engines were designed, a higher pressure was not customary, especially for ships stationed in the tropics. The boilers are made entirely of Siemens-Martin mild steel, all holes being drilled in position. The whole of the riveting was done by hydraulic riveters. It will be observed that the top of the combustion chamber is stayed in a rather unusual manner; but the builders think that this plan, or something equivalent to it, is the most effective way for strengthening this part of the boiler. They argue that so long as the boiler shell is utilized for staying the combustion chamber in the ordinary way, no other resistance can be obtained than that due to the stiffness of the shell plate, for the shell being in equilibrium may be deformed to a comparatively large amount before any considerable resistance is obtained. In the usual method of shaping the sides of the combustion chamber, the required tension on the stay-bolts is only effected by the two outer rows acting as struts and keeping the shell plate in its circular form, the part of the plate between these two rows acting as girders for the middle row of stays.

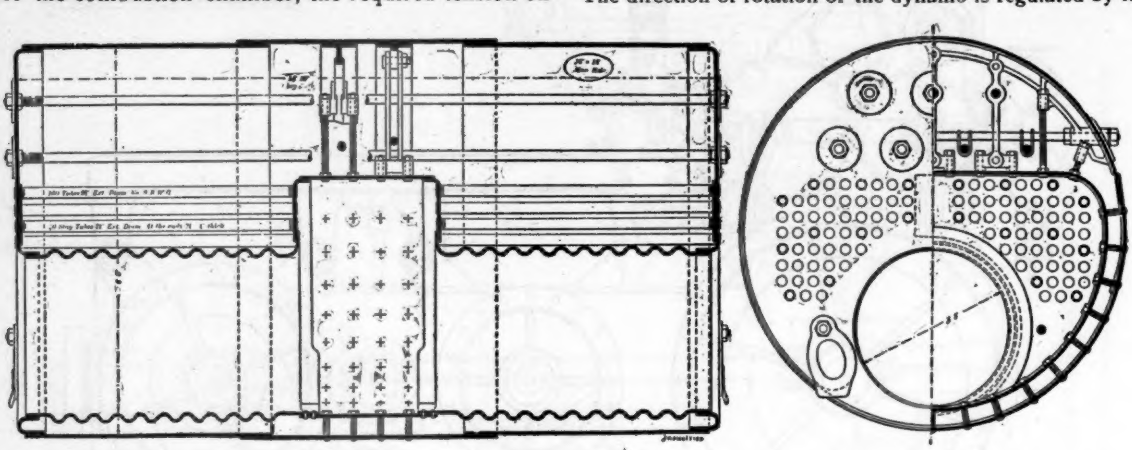


Fig. 4. Fig. 5. Fig. 6.

BOILER FOR GUNBOAT "CERAM," DUTCH COLONIAL NAVY.

In boilers where steam pressures of 180 lbs. to 200 lbs. are to be used, this staying of the sides of the combustion chamber to the shell will have to be carefully attended to, otherwise leakages or accidents may occur. Referring to fig. 4, it will be observed that there are two bridge-stays in the middle of the breadth, which are arranged to allow a man to pass from one end of the boiler to the other. The bridges to which the vertical stays are attached have I section, and are made of cast steel, the outside being turned in the lathe to a true circle, and afterward riveted to the shell. Forced draft can be supplied by closing the stokeholds, the air being drawn from the engine-room and forced into the boiler space by a fan of 5 ft. 6 in. diameter, made by Messrs. Allen & Company, of London. An air pressure of 2 in. of water is easily obtained; but this pressure was not fully utilized on the trial trip. With about half that pressure the engines indicated 804 H.P., as against 606 H.P. obtained with natural draft.

The propeller is of Delta metal. The engines, when running at their full power and at 130 revolutions per minute, worked with very little vibration.

The gunboat *Ceram* is a composite vessel, sheathed with brass, and has the following dimensions: Length, 150 ft.; breadth, 25 ft. 6 in.; mean draft, 9 ft. 4 in.; displacement, 510 tons.

Electric Lighting of Cars in England.

THE Great Northern Railway Company has now four trains running from King's Cross in which, under the direction of Mr. James Radcliffe, the Telegraph Superintendent of the line, a most complete and efficient electrical plant has been fitted, and a fifth installation is in preparation for an express train to Edinburgh. A dynamo and set of accumulators are located in the van under charge of the guard, and a good idea may be formed of the simplicity of the arrangements from the following notice posted in the van:

"*Instructions to Guards.*—During daylight the switch is to be turned 'on' immediately the front brake enters a tunnel and 'off' directly the rear brake emerges from it. The light must be turned 'on' after sunset, five minutes before the train is due to leave the terminal station and on the approach of darkness when running, but must be turned off as soon as the passengers have left the carriages at the end of the journey."

Apart from the guard, all the attention necessary is that, before the starting of the train, an inspector sees that all is in order, and that the lubrication is properly provided for.

The machine found to be most suitable for the work is a Brush, shunt-wound, giving from 45 to 90 ampères of current, according to the speed at which the train travels. This is driven from the axle of the train wheels, multiplication of speed being obtained by means of countershafting introduced between the train axle and the pulley on the driving gear of the dynamo. The direction of rotation of the dynamo is regulated by friction cones, two on the shafting and another fixed on an extension of the dynamo spindle.

The two cones on the shafting are carried by a hollow shaft or sleeve, mounted and free to move on the driving shaft and furnished with spiral slots engaging with projections on the latter. By this means the opposite diameters of the cone on the dynamo spindle are automatically brought against either one or other of the cones on the shafting, according to the direction of the motion of the train, with the result that whichever way the train may be running the dynamo is always driven in one uniform direction, so that no reversal is needed, or any shifting of brushes or readjustment of any kind.

This arrangement has been designed and patented by Mr. Radcliffe. The accumulators are of the E. P. S. manufacture, "11 L" type, and are automatically connected with and disconnected from the dynamo by means of a switch or controller, also designed and patented by Mr. Radcliffe and manufactured by Messrs. Reid Brothers. When the train is at rest the lamps are fed from the accumulators, but when running, and when the E.M.F. of the dynamo rises above that of the accumulators, the dynamo is automatically connected to the accumulators and lamps, between which the current generated is divided, the accumulators taking the surplus over what is required for the lamps; when the speed slackens and the E.M.F. falls below that of the accumulators, the switch or controller automatically cuts the dynamo off, and the lamps are again fed from the accumulators.

A fusible cut-out is employed in such a way that in case of an accidental short circuit or mishap of any kind everything would be disconnected except the lamps with the accumulators, so that the lamps would run on. The cessation of light in any compartment is also guarded against by the system of wiring, a middle wire being run along the roof of each carriage, affording, in case of the accidental giving out of a lamp, a circuit by which the current finds its way to the rest of the lamps; and there being two lamps in each compartment, there is hardly a possibility of its being left in darkness.—*London Electrical Review.*

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

(Continued from page 90.)

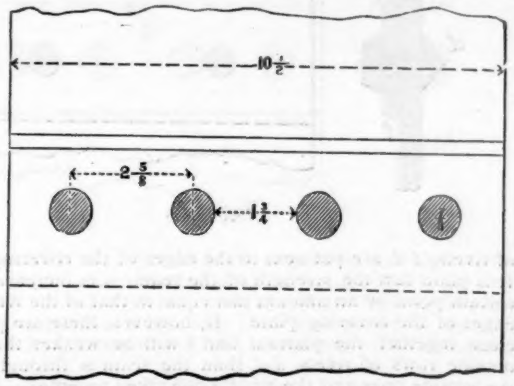
CHAPTER IX—CONTINUED.

THE LOCOMOTIVE BOILER.

QUESTION 207. *What must be the proportions for a single-riveted lap seam made of iron plates and with iron rivets to get the maximum strength?*

Answer. If the plates have a tensile strength and the rivets a resistance to shearing equal to 50,000 lbs. per square inch, THE RIVET HOLES (not the diameter of the rivets cold) SHOULD BE 2⅛ TIMES THE THICKNESS OF THE PLATES, AND THE PITCH OF THE RIVETS FROM CENTER TO CENTER SHOULD BE 7 TIMES AND THE OVERLAP OF THE PLATES 6 TIMES THEIR THICKNESS. Fig. 124 represents a seam of these proportions. In the accompanying table the strength of a seam like that represented by fig. 118 is given in the vertical column *A*, and that of the one shown by fig. 124 is given in column *B*. The strength per lineal inch of the seams is given in the eighth horizontal line. That of the first one is 9,898 lbs., whereas that of the second one is 11,250 lbs. per lineal inch.

Fig. 124.



QUESTION 208. *What difference should there be in the proportions of single-riveted lap seams if made of steel instead of iron plates, and with steel rivets?*

Answer. As steel rivets with sufficient ductility have no greater strength to resist shearing than iron rivets, the one kind should be of the same size as the other; but as steel plates have about 20 per cent. more tensile strength than iron ones, the amount of metal between the rivet holes may be less if the plates are made of steel than if they are of iron. Thus in the seam represented by fig. 124 the rivet hole is ⅞ in. in diameter, and the width of the metal between the holes is 1¾ in. Their sectional area and strength is as follows:

Rivet area, .6013×50,000= 30,065 lbs.

Plate area, 1¾×⅜=.65625×50,000=32,812 lbs.

If the plate is of steel and the space between the rivets is made 1⅜ or 20 per cent. less than shown in fig. 124, then its strength would be as follows:

1⅜×⅜=.5156×60,000=30,937 lbs.,

or a little in excess of the strength of the rivets. THEREFORE, IF STEEL PLATES ARE USED THE PITCH OF THE RIVETS MAY BE 6 TIMES THE THICKNESS OF THE PLATES FOR A SINGLE-RIVETED LAP SEAM OF MAXIMUM STRENGTH.

The strength of a seam proportioned in this way is given in column *C* of the table, and is 22,500 lbs. per lineal inch. A comparison of the strength per lineal inch shows the advantage which is gained in strength by using larger rivets spaced further apart than those ordinarily used, and also the greater strength of seams made of steel plates.

QUESTION 209. *What other methods are there of making boiler seams which are stronger than those which have been described?*

Answer. In this country two rows of rivets are used and also what is called a "*welt*," or *covering-strip*, the latter with both single and double-riveted seams. What are called butt-joints or seams have been used a great deal in Europe, and of late years have been adopted to a limited extent in this country.

QUESTION 210. *How are the rivets arranged when two rows are used?*

Answer. They are sometimes placed just behind each other, as shown in fig. 125, which is called *chain-riveting*.

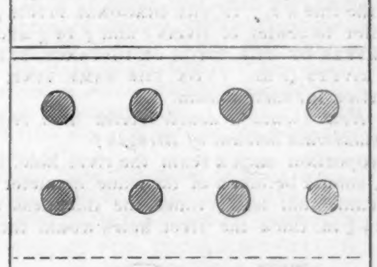


Fig. 125.

A much better arrangement is to place them alternately in the two rows, as shown in fig. 126. Rivets arranged in that way are said to be *staggered*, or placed *zigzag*.

In a single-riveted seam each rivet must resist a strain equal to that on the metal between two adjoining rivets. In a double-riveted seam one-half the strain on the metal between two contiguous rivets, in one row, is resisted by a rivet in the other row. Thus in fig. 126 the rivet *g* will take one-half the strain on the metal between the rivets *c* and *f*. Consequently the area of the metal between *c* and *f*, and their distance apart, may be very much greater than it would be in a single-riveted seam.

STRENGTH OF DIFFERENT KINDS OF RIVETED SEAMS.

		A	B	C	D	E	F	G	H	I
		Single-Riveted Lap Seam, Fig. 118.	Single-Riveted Lap Seam, Fig. 124.	Single-Riveted Lap Seam.	Double-Riveted Lap Seam, Fig. 126.	Double-Riveted Lap Seam.	Double-Riveted Lap Seam, Fig. 132.	Single-Riveted Lap Seam, Fig. 118, with Welt.	Single-Riveted Lap Seam, Fig. 124, with Welt.	Single-Riveted Lap Seam—with Welt.
1	Material of plates	Iron.	Iron.	Steel.	Iron.	Iron.	Steel.	Iron.	Iron.	Steel.
2	Diameter of rivet holes	11/16 inch.	⅞ inch.	⅞ inch.	¾ inch.	⅞ inch.	⅞ inch.	11/16 inch.	⅞ inch.	⅞ inch.
3	Straight pitch of rivets	1⅞ "	2⅝ "	2¼ "	3 "	3⅝ "	3⅝ "	1⅞ "	2⅝ "	2⅝ "
4	Diagonal pitch of rivets	....	....	....	2¼ "	2¾ "	2 3/11 "	....	....	....
5	Strength of rivets to resist *shearing*	74,240 lbs.	131,250lbs.	131,250lbs.	132,010lbs.	180,390lbs.	180,390lbs.	148,480lbs.	262,500lbs.	262,500lbs.
6	Strength of plates through rivet holes to resist *tearing*	89,060 "	120,260 "	123,748 "	126,562 "	182,810 "	177,185 "	114,840 "	153,070 "	163,120 "
7	Strength of plates in front of rivets to resist *crushing*	92,812 "	118,125 "	118,125 "	151,875 "	177,183 "	177,183 "	185,624 "	236,250 "	236,250 "
8	Minimum strength of seam per lineal inch	9,898 "	11,250 "	13,125 "	14,062 "	14,318 "	16,874 "	15,312 "	14,578 "	18,124 "
9	Strength of plate per lineal inch	18,750 "	18,750 "	22,500 "	18,750 "	18,750 "	22,500 "	18,750 "	18,750 "	22,500 "
10	Strength of seam in percentage of solid plate	52.78	60.	58.33	74.46	76.36	75.	81.66	77.75	80.55

QUESTION 211. *What are the usual proportions for double-riveted seams?*

Answer. The following table, copied from "The Elements of Machine Design," by W. C. Unwin, gives proportions for such seams which are very commonly used:

PROPORTIONS FOR DOUBLE-RIVETED SEAMS.

Iron Plates, Iron Rivets.			Steel Plates, Iron Rivets.		
Thickness of Plates.	Diameter of Rivets.	Pitch of Rivets.	Thickness of Plates.	Diameter of Rivets.	Pitch of Rivets.
$\frac{3}{8}$ inch.	$\frac{3}{4}$ inch.	3 inch.	$\frac{3}{8}$ inch.	$\frac{3}{4}$ inch.	$2\frac{7}{16}$ inch.
$\frac{7}{16}$ "	$\frac{13}{16}$ "	$3\frac{1}{16}$ "	$\frac{7}{16}$ "	$\frac{13}{16}$ "	$2\frac{1}{2}$ "
$\frac{1}{2}$ "	$\frac{7}{8}$ "	$3\frac{1}{8}$ "	$\frac{1}{2}$ "	$\frac{7}{8}$ "	$2\frac{9}{16}$ "
$\frac{9}{16}$ "	$\frac{7}{8}$ "	$3\frac{1}{8}$ "	$\frac{9}{16}$ "	$\frac{7}{8}$ "	$2\frac{9}{16}$ "
$\frac{5}{8}$ "	$\frac{15}{16}$ "	$3\frac{3}{16}$ "	$\frac{5}{8}$ "	$\frac{15}{16}$ "	$2\frac{5}{8}$ "
$\frac{3}{4}$ "	$1\frac{1}{16}$ "	$3\frac{5}{16}$ "	$\frac{3}{4}$ "	$1\frac{1}{16}$ "	$2\frac{3}{4}$ "
$\frac{7}{8}$ "	$1\frac{1}{8}$ "	$3\frac{3}{8}$ "	$\frac{7}{8}$ "	$1\frac{1}{8}$ "	$2\frac{13}{16}$ "
1 "	$1\frac{1}{4}$ "	$3\frac{1}{2}$ "	1 "	$1\frac{1}{4}$ "	$2\frac{15}{16}$ "

QUESTION 212. *What should be the diagonal pitch of the rivets in a double-riveted seam—that is, the distance between the centers of the rivets c and g or g and f of fig. 126?*

Answer. It has been found by experiment* that the net metal measured on a zigzag line, *c g f*, fig. 126, should be about one-third in excess of that measured straight across. If there is not that much excess the plates will be weaker straight across, and will break on the line *a b*. IF THE DIAGONAL PITCH (or the distance from center to center of rivets *c* and *g* or *g* and *f*) IS MADE THREE-QUARTERS OF THE PITCH OR DISTANCE BETWEEN THE CENTERS OF RIVETS (*c* and *f*) ON THE SAME LINE, it will give a good proportion for such a seam.

QUESTION 213. *How should a double-riveted seam be proportioned to have the maximum amount of strength?*

Answer. To proportion such a seam the rivet hole, for the reasons explained, should be taken of the same diameter as for a single-riveted seam—that is, $2\frac{1}{4}$ times the thickness of the plates. For plates $\frac{3}{8}$ in. thick the rivet holes would therefore

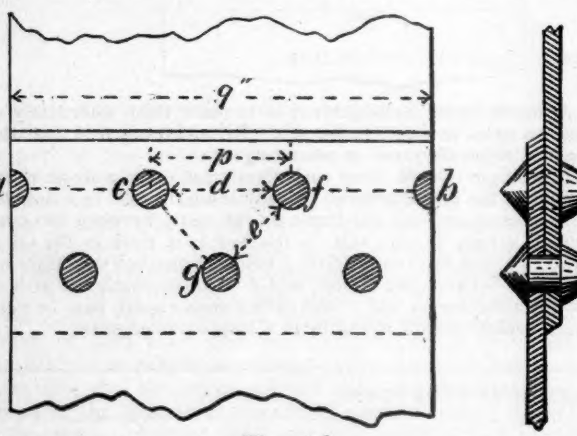


Fig. 126.

be $\frac{7}{8}$ in. diameter. It has been explained, and is shown in fig. 126, that in a seam with two rows of rivets the rivet strength—that is, their resistance to shearing, is twice that of a seam with one row, because the number of rivets is doubled. Consequently the amount of metal between the rivets may be twice as great as in a single-riveted seam. It has been found by experiment and calculation that if the diameter of rivets for a double-riveted seam is made $2\frac{1}{4}$ times the thickness of the plates, and the pitch—with iron plates—is made 11 times, and for steel plates $9\frac{1}{8}$ times their thickness, that it will give a seam of nearly equal strength to resist the shearing of the rivets and the tearing and crushing of the plates.

The strength of such seams has been calculated, and the results are given in columns *E* and *F* of the table. Column *D* gives the strength of a seam, represented by fig. 126, and proportioned as specified in the table of proportions for double-riveted seams. The strength of these per lineal inch in the eighth horizontal line of the large table shows the superiority of double-riveting, and also the gain from the use of large rivets and greater pitch and of steel plates.

The distance that the rivets should be spaced on a zigzag line is three-quarters of the pitch on a straight line, or $8\frac{1}{4}$ times the thickness of iron and 7 times that of steel plates.

QUESTION 214. *What is the form of construction of boiler seams made with a lap and a welt or covering-strip?*

Answer. The plates (*a*, *b*, fig. 127) are lapped over each other as for an ordinary seam. Another plate, *c*, is then placed on the inside of the seam and bent so as to conform to the lap of the two plates. The rivets *r r*, whether a double or single row, pass through all three plates, and two more rows

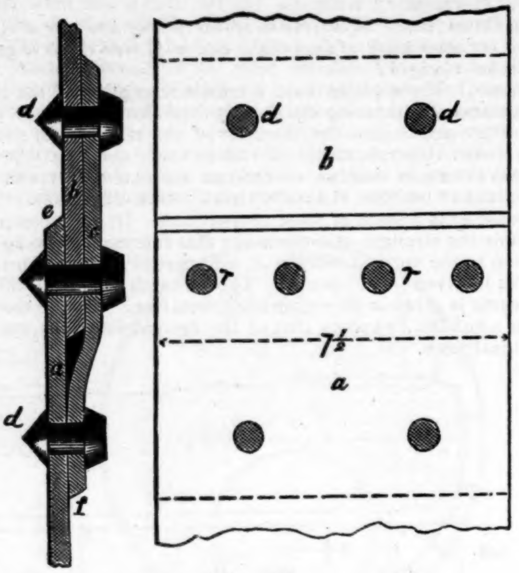


Fig. 127.

of rivets, *d d*, are put next to the edges of the covering plate, *c*. It is plain that the strength of the seam, *r*, is increased up to a certain point by an amount just equal to that of the rivets in the edges of the covering plate. If, however, these are placed too close together, the plates *a* and *b* will be weaker through the outside rows of rivets, *d d*, than the seam is through either of the outside ones and the middle one taken together. If, for example, we take a single-riveted seam, like that shown in fig. 118, whose strength is only a little more than half that of the solid plate, and should add to it a covering plate, as shown in

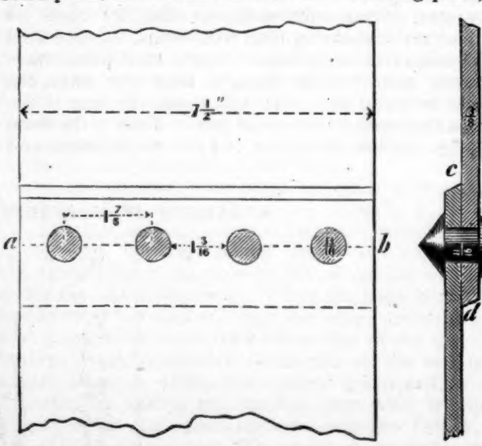


Fig. 118.

fig. 127, and then space the rivets in the edges of the covering plate the same distance apart as in the middle seam, then obviously the plates would be just as liable to break through the outer rows of holes as through the center row before the covering plate was added. If, however, the holes in the two outside plates are spaced at say twice the distance apart, or $3\frac{3}{4}$ in., then the only way the seam can break through the outer rows of holes is by shearing the rivets, because the plates between the holes are then stronger than the rivets. But before these rivets can be sheared, the center seam must give way. Thus the strength of such a seam is equal to THE SUM OF THE STRENGTH AT THE WEAKEST POINTS OF THE MIDDLE AND THE OUTSIDE SEAMS. The strength of the plates between the holes of the

* See "Report upon Experiments and Abstract of Results of Experiments on Riveted Joints" in *Proceedings* of the Institution of Mechanical Engineers for April, 1885.

outside rows of rivets must, however, be as great as the sum referred to, otherwise the seam will be the weakest at that point, and the failure will occur there. The rivets in the outside rows should be spaced at least twice as far apart as those in the middle seam. The number of rivets to resist shearing will then be 50 per cent. greater than in a single-riveted seam. Welted seams of this kind are sometimes made with a double row of rivets between the two outer rows.

QUESTION 215. *What advantage has such a seam over seams without a welt?*

Answer. The strength of a seam is increased by an amount equal to that of the welt. Thus, column *G* gives the strength of a seam like that in column *A* with a welt added, column *H* gives the strength of seam *B* with a welt, and column *I* gives the strength of seam *C* welted. A comparison of the strength of the different seams per lineal inch in the eighth horizontal line shows the great increase in strength which results from the addition of a welt.

QUESTION 216. *How are butt-joints or seams made?*

Answer. In these the ends of the two plates abut against each other, as shown at *a* in figs. 128 and 129, with a covering strip

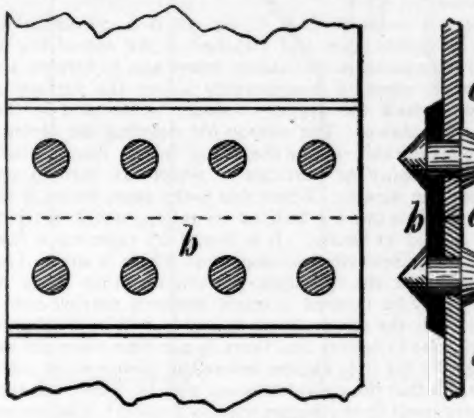


Fig. 128.

or welt—which is shaded black in the engraving—on one or both sides. In some cases a single welt or covering strip, *b*, fig. 128, is used with either two or four rows of rivets. Such a seam has no more strength than a lap seam like those shown by figs. 118 or 126. In fact, it consists of two lap seams. The circumferential seams of boilers are, however, often made in this way in Europe, so as to get all the plates in the cylindrical part of the boiler flush with each other.

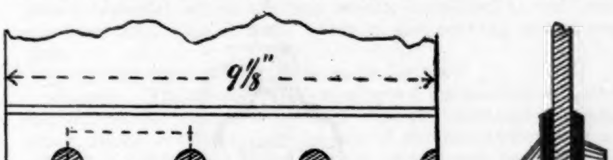


Fig. 129.

QUESTION 217. *What is the strength of butt seams or joints compared with those which have been described?*

Answer. A butt seam with double strips and quadruple rows of rivets is little, if any, stronger than a double-riveted lap seam properly proportioned. The resistance to the crushing action of the rivets limits the strength of both kinds of seams, and in that respect they may be nearly equally strong.

QUESTION 218. *What advantages have butt seams with double welts, as shown in fig. 129?*

Answer. Such seams are often used for the longitudinal seams of boilers because a lap seam like that shown in fig. 130, when subjected to a tensile strain, will tend to draw into the form shown in fig. 131—that is, the tendency is to draw into a straight line, and a bending strain will be exerted on them at *a* and *b*. This strain also tends to pull the plates apart where they lap over each other, whereas in a seam like that shown in fig. 129 the strain on the plates and on the covering strips *a* and *b* is in a line parallel with their surfaces, and therefore no bending action is exerted on them.

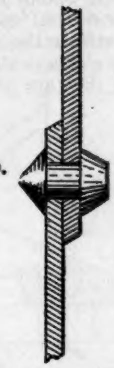


Fig. 130.

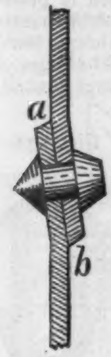


Fig. 131.

It is found by experience that boilers are very often corroded along the edges of the plates of lap seams just where the bending action takes place. It is probable that when iron or steel is subjected to a high degree of tension, and at the same time exposed to substances which corrode them, that their action is most rapid where the strain is greatest. At any rate, it is found that much less corrosion occurs with butt seams which have double welts than with lap seams.

QUESTION 219. *What are the proportions commonly used for butt seams?*

Answer. The following table is from Wilson's "Treatise on Steam Boilers," and gives the proportions for double-riveted butt joints which are very commonly used:

PROPORTIONS FOR DOUBLE-RIVETED BUTT JOINTS WITH DOUBLE STRIPS.

Thickness of Plate.	Diameter of Rivet.	Thickness of Strip.	Pitch of Rivets.
⅜ inch.	⅝ inch.	¼ inch.	2½ inch.
$\frac{7}{16}$ "	⅝ "	¼ "	2⅝ "
½ "	⅝ "	$\frac{5}{16}$ "	2¾ "
$\frac{9}{16}$ "	$\frac{11}{16}$ "	$\frac{5}{16}$ "	2⅞ "
⅝ "	¾ "	⅜ "	3 "
$\frac{11}{16}$ "	¾ "	⅜ "	3⅛ "
¾ "	⅞ "	$\frac{7}{16}$ "	3¼ "
$\frac{13}{16}$ "	⅞ "	$\frac{7}{16}$ "	3½ "
⅞ "	1 "	½ "	3⅝ "
$\frac{15}{16}$ "	1 "	½ "	3¾ "
1 "	1⅛ "	$\frac{9}{16}$ "	4 "

QUESTION 220. *How should a quadruple-riveted butt seam with double strips of maximum strength be proportioned?*

Answer. The diameter and pitch of rivets should be proportioned in the same way as for a double-riveted lap seam. A butt seam has usually an excess of rivet area to resist shearing, because the rivets are subjected to a double shear. The strength of such a seam is, however, limited by the resistance of the metal in front of the holes to crushing. There is, therefore, not much difference in the strength of well-proportioned double-riveted lap and butt seams.

QUESTION 221. *What influence does the size of the rivet-heads and ends have on the strength of a seam?*

Answer. It has been found that an increase of about one-third in the weight of the rivets (all this increase going to the heads and ends) was found to add about 8½ per cent. to the resistance of the joint. RIVETS, BEFORE THEIR HEADS ARE FORMED, SHOULD PROJECT BEYOND THE PLATES A DISTANCE EQUAL TO ABOUT 3 TIMES THEIR DIAMETERS TO GIVE SUFFICIENT MATERIAL FOR THE HEADS.

QUESTION 222. *What practical consideration must govern the proportions of riveted seams?*

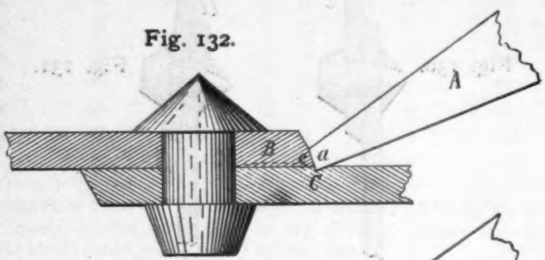
Answer. It must be determined what is the greatest pitch of rivets which can be used in any particular case. Generally it becomes a question of how wide a pitch can be used and the

boiler be made tight by caulking. The proportions for riveted seams given in the tables are such as have been extensively used in practice. With improved material and workmanship, doubtless larger rivets than the sizes given in the tables can be used, and they can be spaced farther apart and still make a tight joint, and a nearer approximation can be made to the dimensions given by the rules for proportioning seams of maximum strength.

QUESTION 223. *How are the seams of boilers made tight?*

Answer. By what is called *caulking*—that is, by the use of a blunt instrument, *A*, fig. 132, somewhat resembling a chisel, the end, *a*, of which is placed against one of the edges of the plate *B*, which is then compressed or riveted down by blows of a hammer, somewhat as the joints between the planks of a ship are made tight. The edges, *e*, of the plates—called the *caulking edges*—are sometimes planed before they are put together, but

Fig. 132.



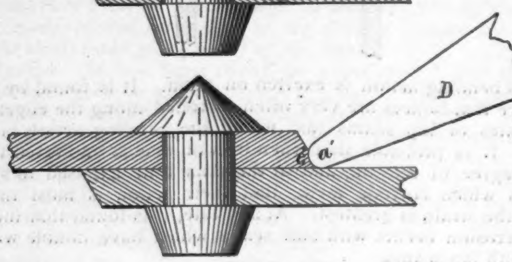


Fig. 133.

more commonly they are cut or trimmed off with a chisel. In this process the plate is often injured seriously by the carelessness of workmen, who sometimes allow the chisel to cut a groove in the plate at *C*, under the edge, thus weakening it at a point where the greatest strength is needed. If driven too hard the tool is liable to force the plates *B* and *C* apart, as indicated by the dotted line below *B*. For these reasons Mr. Connery, foreman of the boiler shop of the Baldwin Locomotive Works in Philadelphia, devised a system of caulking with a tool, *D*, having a round nose, *a'*, as shown in fig. 133. With this there is no liability to groove the lower plate nor force the plates apart.

QUESTION 224. *How much water is usually carried in a locomotive boiler?*

Answer. There must always be enough water in the boiler to cover completely all the parts which are exposed to the fire, otherwise they will be heated to so high a temperature as to be very much weakened or permanently injured. In order to be sure that all the heating surface will at all times be covered with water, it is usually carried so that its surface will be from 4 to 8 in. above the crown-sheet.

QUESTION 225. *How much space should there be over the water for steam?*

Answer. No exact rule can be given to determine this. It may, however, generally be assumed that the more steam space the better. In order to increase the steam room, locomotive boilers are very generally made in this country with what is called a *wagon-top*, shown in fig. 90—that is, the outside shell of the boiler over the fire-box is elevated at *X* from 4 to 12 or even 18 in. above the cylindrical part.

QUESTION 226. *What is a steam-dome, and for what purpose is it intended?*

Answer. A *steam-dome*, *U U*, fig. 90, is a cylindrical chamber made of boiler-plate and attached to the top of the boiler. Its object is to increase the steam room and to furnish a reservoir which is elevated considerably above the surface of the water, from which the supply of steam to be used in the cylinders can be drawn. The reason for drawing the steam from a point considerably above the water is that during ebullition more or less spray or particles of water are thrown up and mixed with the steam. When this is the case, steam is said to be *wet*, and when there is little or no unevaporated water mixed with it it is said to be *dry*. It is found by experience that wet steam is much less efficient than that which is dry. There is also danger that the cylinders, pistons, or other parts of the machinery may be injured if much water is carried over from the boiler with the steam, because water will be discharged so slowly from the cylinders that there is not time when the engine is running fast for it to escape before the piston must complete its stroke, so that the cylinder-heads will be "*knocked out*," or the cylinder itself or the piston will be broken. The reason for drawing or "*taking*" steam from a point considerably above the water is because there is less spray there than there is near the surface, and the hottest steam, which is also the dryest, ascends to the highest part of the steam space.

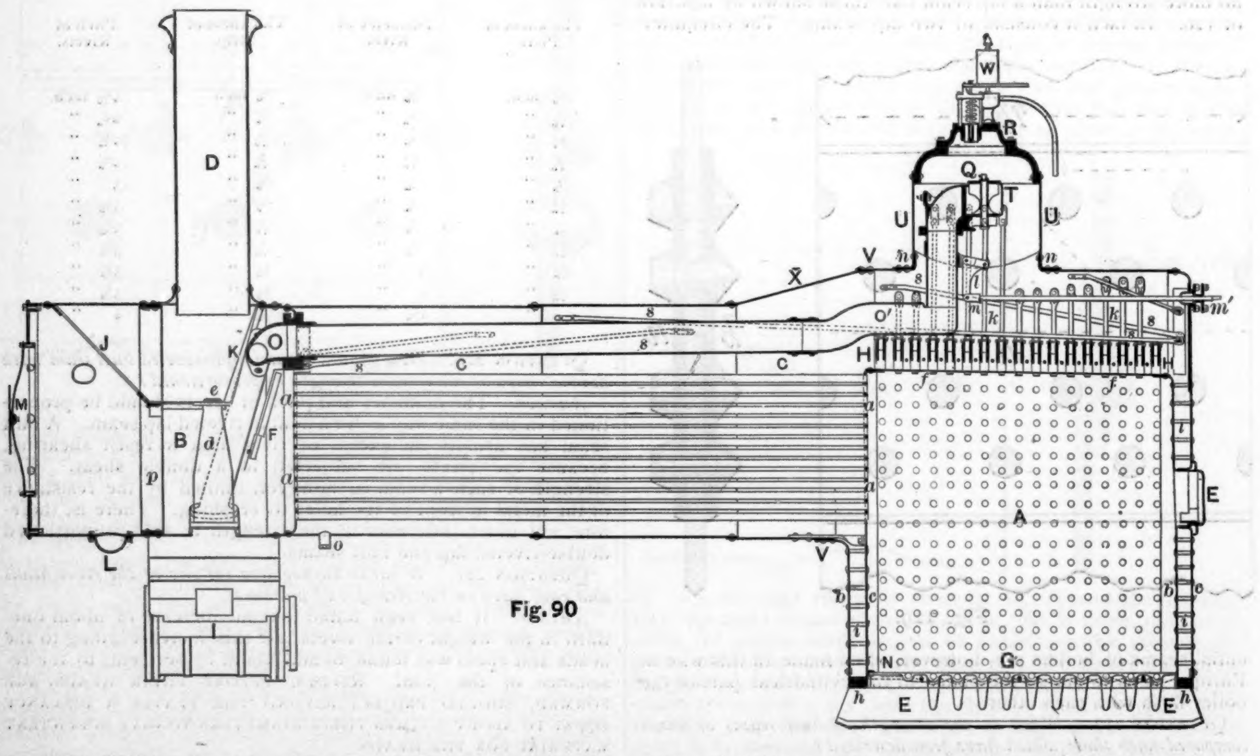


Fig. 90

QUESTION 227. *Where is the dome usually placed?*

Answer. In this country it is usually placed over the fire-box, but in Europe it is often placed further forward, either about the center of the boiler or near the front ends of the tubes.

QUESTION 228. *How is the steam conducted from the dome to the cylinders?*

Answer. By a pipe, *T C' O*, fig. 90, called the *dry-pipe*, which extends from the top of the dome to the front tube-plate. On the front side of the tube-plate and inside the smoke-box two curved pipes, called *steam-pipes*, are attached to the dry-pipe at one end, and to the cylinders at the other. The vertical portion, *Q*, of the dry-pipe in the dome, sometimes called the *throttle-pipe*, is usually made of cast iron, the horizontal part of wrought iron, and the steam-pipes of cast iron.

QUESTION 229. *How is the loss of heat from locomotive boilers by radiation and convection prevented?*

Answer. Usually by covering the boiler and dome with wood, called *lagging*, about ¾ in. thick, which is a poor conductor of heat, and then covering the outside of the wood with

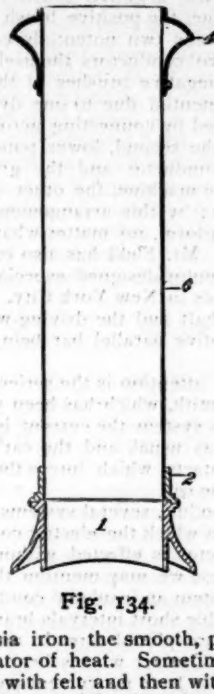


Fig. 134.

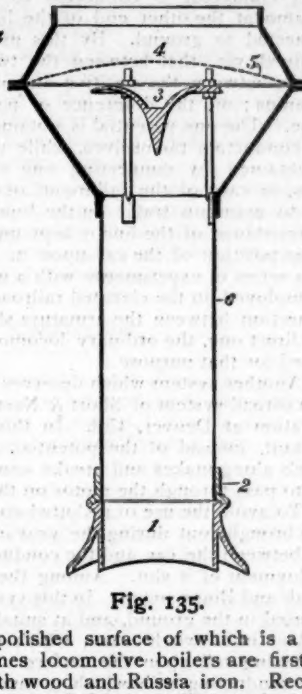


Fig. 135.

Russia iron, the smooth, polished surface of which is a poor radiator of heat. Sometimes locomotive boilers are first covered with felt and then with wood and Russia iron. Recently plastic material, which hardens after it is applied to the boiler, has been used a good deal. This is also covered with Russia iron.

QUESTION 230. *What is the smoke-box for?*

Answer. The smoke-box *B* is simply a convenient receptacle for the smoke before it escapes into the chimney or smoke-stack, which is attached to the top of the smoke-box. It also affords a convenient place for the steam and exhaust-pipes, where they are surrounded with hot air and smoke, and not exposed to loss of heat by radiation.

Formerly smoke-boxes were made without the portion shown in fig. 90, which extends in front of the ring *p*. This part, called the *extended front end*, has been added to give room for appliances to arrest the sparks. These consist of a deflector, *F*, in front of the tubes and wire netting, *J K*, which cause the heavy sparks and cinders to be thrown forward, and prevent them from being carried up the chimney. They are thus deposited in the front end, from which they can be removed by a suitable aperture, *L*, at the bottom.

The front of the smoke-box is usually made of cast iron, with a large door, *M*, in the center, which affords access to the inside.

QUESTION 231. *How are the chimneys or smoke-stacks of locomotives constructed?*

Answer. The forms of smoke-stacks which have been used are almost numberless. When an extended front-end, such as is shown in fig. 90, is used, the chimney often consists of merely a straight pipe, *D*, as represented. A larger drawing of this stack is given in fig. 134. For burning bituminous coal and wood, what is called a *diamond stack*—probably from the shape of the outline of the top—as shown in fig. 135, is used a great deal. This consists of a central pipe, 1, 4, fig. 135, and a conical-shaped cast-iron plate, 3, called the *cone* or *spark deflector*, which, as the latter name implies, is intended to deflect the motion of the sparks and cinders which are carried up with the ascending current of smoke and air in the pipe 1, so as to prevent them from escaping into the open air while they are incandescent, or "alive." A wire netting, 5, is also provided, which is intended as a sort of sieve to enclose the sparks and cinders, and at the same time allow the smoke to escape. The receptacle below the cone is intended as a chamber in which the burning cinders will be extinguished before they escape. For burning anthracite coal, a simple straight pipe, as shown in fig. 134, without a deflector or wire netting, is ordinarily used. For burning wood a chimney or smoke stack of the form shown in fig. 135 is sometimes used, but more generally one of the form shown in fig. 136, which is a wide stack, with a straight interior pipe 8, a cone 3 and wire netting 5. Inside the outer shell 6 there is an inner box or bonnet 7. The sparks collect in the space outside the straight pipe 8, and can be removed through the hand-hole 9.

QUESTION 232. *What are the proportions and materials usually employed in the construction of smoke-stacks?*

Answer. The inside pipe 6, fig. 135, is usually made of the

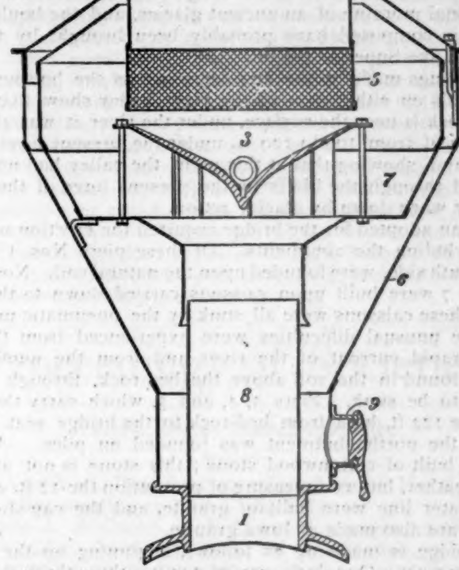


Fig. 136.

same diameter as the cylinders, or an inch or two smaller. For the other dimensions there are no established rules, excepting for the height of the top of the chimney above the rail, which is usually from 14 to 15 ft. The outsides of smoke-stacks are made of sheet iron, but the upper part is now sometimes made of cast iron, so as to withstand the abrasion of the sparks and cinders longer than sheet iron will. For very warm and damp climates, the outsides of smoke-stacks are sometimes made of copper to resist corrosion, which is very destructive to all iron structures in those countries. The wire netting is made of iron or steel wire from $\frac{1}{16}$ to $\frac{1}{30}$ in. in diameter, and with from 3 to 4 meshes to the inch.

(TO BE CONTINUED.)

The Suram Tunnel in Russia.—A letter from a correspondent at Suram, addressed to the *Novoe Vremya*, contradicts the rumor that has circulated of late denying that Russia had seriously taken in hand the construction of a tunnel through the ridge of the Lesser Caucasus, between Batoum and Tiflis. According to this correspondent, fair progress has already been made at one end of the tunnel, the excavation having already penetrated over 1,000 ft., while at the other 200 ft. of rock have been cut away. The boring machines are of the latest description, and every improvement in tunneling is being adopted. The total length of the tunnel will be 11,460 ft., and it is expected that it will be finished by the end of next year. The cost, with that of the loop line, will exceed $5,000,000. The tunnel at one part passes through clay and will require to be lined with stone, but a good deal consists of solid rock, which requires to be blasted by dynamite. Pending the construction of the new line, the traffic over the Suram Pass still continues in a very congested condition. To relieve the congestion the Government has sanctioned the laying of pipe lines, 37 miles long, over the pass. Messrs. Nobel & Rothschild have already received permission to lay down pipe lines of their own, and other competitors are in the field.

The improvement of the line from Batoum to Tiflis is of interest here, as any increase in the facilities of transportation will increase the power of the Russian producers to compete with American petroleum in the European markets.

Manufactures.

The Sibley Bridge Over the Missouri.

THE latest of the great bridges over the Missouri River has just been completed at Sibley, near Kansas City, for the use of the new Chicago, Santa Fé & California Railroad. The surveys for this bridge were begun early in January, 1887, and the location finally adopted was at the lower end of the Sibley Bend. At this point the engineers found a shelf of rock extending across the river only 30 ft. below the water level. Just above this shelf of rock there crops out on the shore a remarkable object which has long been a land mark of the Missouri, and which is a huge mass of boulders of granite, porphyry, and metamorphic sandstone. It has long been considered as really the terminal moraine of an ancient glacier, and the boulders of which it is composed have probably been brought by the ice from the Lake Superior region.

The borings made by the engineers across the bottom lands to the bluffs on either side of the river valley show that while the bed-rock is near the surface, under the river it was abraded to a depth of from 100 to 120 ft. under the present level of the bottom land, showing that at this point the valley had not been excavated through the bluffs by the present force of the river, but really worn down by glacial action.

The plan adopted for the bridge required the erection of eight piers, including the abutments. Of these piers Nos. 1 and 2, on the south side, were founded upon the natural soil. Nos. 3, 4, 5, 6, and 7 were built upon caissons carried down to the bed-rock. These caissons were all sunk by the pneumatic method, and some unusual difficulties were experienced from the extremely rapid current of the river and from the number of boulders found in the soil above the bed-rock, through which they had to be sunk. Piers 3, 4, and 5, which carry the river spans, are 122 ft. high from bed-rock to the bridge seat. Pier No. 8 of the north abutment was founded on piles. All the piers are built of cottonwood stone; this stone is not affected by the weather, but as a measure of precaution the 12 ft. adjoining the water line were built of granite, and the cap-stones of the piers are also made of Iowa granite.

The bridge is made up as follows, beginning on the south side of the river: One deck span of 200 ft.; three through spans of 400 ft. each over the river; one deck span of 250 ft. and two of 175 ft. each over the sand-bar; 1,900 ft. in length of iron viaduct over the bottom land, making a total length of bridge of 3,900 ft. In addition to this there is a further length of 3,600 ft. of wooden trestle across the bottom lands which is to be filled up and made a solid embankment.

The bridge was built under charge of Mr. A. A. Robinson, Chief Engineer, with Mr. Octave Chanute as Consulting Engineer. The immediate charge of the work rested upon John Wallace, Resident Engineer, with Otto Sonne and G. J. Bell as assistants. The substructure was built by Sooysmith & Company, of New York; the contractor for the superstructure was the Edge-Moor Iron Company, of Wilmington, Del.

The 400 ft. spans are of steel, the rest of the structure and the viaduct being of iron.

A remarkable feature about this bridge was the short time in which it was built. Work was actually begun April 8, 1887, and the bridge was open for travel January 25, 1888, the whole time employed being 293 days only, less than has been required for the erection of any other bridge over the Missouri. It was originally intended to have the bridge completed by January 1, but the delay was due partly to the unusual height and the rise of the river in June, which delayed the work of sinking the caissons, and the very stormy weather the latter half of December, which interrupted the work on the erection of the superstructure.

The total cost of the bridge was $800,000, a little over $200 per linear foot. This is by no means large, considering the length of span adopted over the river.

Electric Street Railroads.

THE *Electrical Review* gives the following summary of progress made during 1887 in relation to electric motors and railroads:

"The year 1887 has been eminently fruitful in the large number of electric railroads undertaken and in the new systems brought out. In so far as the electric motors themselves are concerned, a number have made their appearance, which, as in the case of the dynamo, chiefly present modifications of details intended to increase their efficiency, and among which we may mention those of Baxter, Immisch, Silvey, the Cleveland, Card, Hyer, Thone, C. & C, etc.

"But in the department of railroad work sufficient has been done to warrant a more detailed description in not a few cases. Thus early in the year Mr. Stephen D. Field made public a system of his which is designed especially for street railroad work. In this system two conduits are employed, the tops of which form the bearings for the rail, the flange on the wheel entering the slot in the top. In each of these conduits an insulated conductor is placed, each one of which is connected to a dynamo placed at each end of the line. The conductor in one conduit is connected with the positive brush of the dynamo, the negative brush of which is connected to the ground; and the other conductor is connected to the negative brush of the dynamo at the other end of the line, the positive brush being connected to ground. By this means two potentials can be obtained, viz., that between the two conductors themselves—that is, between the positive and negative brushes of the two dynamos; or, the difference of potential due to one dynamo alone. The one potential is obtained by connecting across the two conductors themselves, while the second, lower potential, is obtained by connecting one conductor and the ground. Thus, in case of the failure of one machine, the other is still able to maintain traffic on the line; by this arrangement also the resistance of the line is kept uniform, no matter what may be the position of the car upon it. Mr. Field has also carried out a series of experiments with a motor designed especially to be employed on the elevated railroads in New York City. The connection between the armature shaft and the driving-wheels is a direct one, the ordinary locomotive parallel bar being employed for that purpose.

"Another system which deserves attention is the series electric railroad system of Short & Nesmith, which has been put in operation at Denver, Col. In this system the current is kept constant, instead of the potential, as usual, and the car as it travels along makes and breaks contacts, which forces the current to pass through the motor on the car.

"To avoid the use of a slotted conduit, several systems have been brought out during the year in which the electric connection between the car and the conductor is effected without the employment of a slot. Among these we may mention that of Pollak and Binswanger. In this system an insulated conductor is buried in the ground, and at suitable short intervals branches are laid into switch-boxes, which are placed directly under a conducting rail upon the surface. Contact wheels bear upon these conducting rails which normally have no current passing in them. Upon the car, however, is carried a magnet which acts upon an armature placed in the contact boxes below the surface, and by the attraction of which the armatures are raised. This closes a contact which connects the surface conducting rail with the main insulated conductor below the surface, which then furnishes current to the motor on the car. As soon as the car has passed these points, the armature in the contact box is released, and the connection broken, whereupon a similar connection takes place at the next contact box; and thus a continuous current for the motor is obtained. Hence the surface conducting rail only affords a local circuit and may be said to be a traveling conductor, energized only at the point where the car happens to be at any particular moment.

"Another device intended to overcome the use of a slot is that of Irish, in which a flexible conduit permits connection to be made with a surface conducting rail and the conductor within the conduit.

"We must also mention here the elevated railroad experiment of Sprague, as well as the system of Enos, designed for elevated railroads. Not a little attention has been devoted during the year to the various methods of gearing the motor to the axles of the car, and an excellent *résumé* of these has been given by Mr. A. Reckenzaun before the American Institute of Electrical Engineers. Before that body, also, a valuable statistical table of the electrical railroads of America and Europe has been given by Mr. T. C. Martin. It is specially worthy of note that the year has seen the inauguration of the first mine railroad in this part of the world, that of Schlesinger, in the Lykens Valley coal mine, the success of which will no doubt lead to the construction of numerous others in the future."

Manufacturing Notes.

THE Linden Steel Company in Pittsburgh has finished the armor-plates for the new cruiser *Baltimore*, and is now at work on the plates for the *Newark*. The armor-plates are of steel, 4 in. thick, and most of them 18 ft. long.

THE Newport Iron & Steel Company, a new corporation, has bought the entire plant and property of Swift's Iron & Steel Works, and will continue the manufacture of plate, bar, angle, and boiler iron, sheet steel, and similar work.

IT is stated that the United States Rolling Stock Company has bought the car shops at Anniston, Ala., and that they will be much enlarged, making an extensive plant.

THE contract for the new Harvard bridge in Boston has been awarded by the commissioners to the Boston Bridge Company, although there were two lower bids. The amount of the bids for the superstructure of the bridge ranged from $173,700 to $216,876.

THE Schenectady Locomotive Works in Schenectady, N. Y., last year turned out 247 locomotives, an average of over 20 a month. The shops are now being enlarged by a new blacksmith shop 85 × 350 ft. in size. Arrangements will be made for lighting this shop with electric lights.

THE Baldwin Locomotive Works in Philadelphia last year built 653 locomotives, or over two a working day. This is the best record yet made, and passes that of 1882, when 563 locomotives were turned out. The number of men employed last year averaged about 3,000. Up to January 1, 1888, these works had turned out in all 8,975 locomotives.

JOHN ADT & SON in New Haven, Conn., recently finished a wire-cutting machine of a special pattern, intended to cut wires for the wire brushes of dynamos. This machine has been shipped to the Edison Electric Company at Berlin, Germany, and will be used in the shops of that company.

Marine Engineering.

THE boats used on the Pennsylvania Railroad ferry across the Hudson River at New York have all been supplied with the Williamson steam steering apparatus. This is also to be put on the ferry-boats of the Hoboken Land & Improvement Company.

A NEW steel steamship 300 ft. long and 46 ft. beam is to be built at William Cramp & Sons' yard, Philadelphia, for the Clyde line between New York and Southern ports. The new vessel will have triple-expansion engines and all the latest improvements in construction.

THE twin-screw steamer *Zizania* for the United States Lighthouse Department was launched from the yard of H. A. Ramsay & Co., Baltimore, January 17. The *Zizania* is built of steel and is a novel type of marine architecture, as she has not only twin screws, but each propeller works through a separate and independent sternpost; in fact, she is a dual ship from her dead flat extending aft, having two keels, and a single keel forward. She is 180 ft. long over all, 29 ft. beam, and 11 ft. depth of hold. Her construction is remarkable for strength, and her plating is heavy for a vessel of her class. The frames are but 18 in. apart, and the plating forward of the collision bulkhead is double. She has six absolutely water-tight bulkheads. The deck frames of lower and upper decks are of steel beams. The upper deck is plated with steel and covered with white pine. Below the main deck forward is the forecastle for the crew, and abaft the engine bulkhead in another water-tight compartment is the ward-room for the officers. The inspector's cabin and chart-room are located on the main deck, and above all is a light promenade deck extending over three-quarters of the vessel's length, where is located the pilot-house and captain's state-room. The steel plating of the hull runs up to the rail, so that her bulwarks are of steel also. In addition to her main U-shaped keel she is provided with heavy bilge keels, which will prevent violent rolling. Her rig will be that of a topsail schooner, all the standing rigging being of steel-wire rope. A steam derrick forward on the main deck is to be operated by an independent engine, and is to be used in hauling the heaviest class of buoys in and out of her hold. There are two compound engines, one to each screw; they have cylinders 15 in. and 28 in. diameter and 27-in. stroke. Both engines are finished with surface-condensing apparatus. There is one overhead return flue boiler built of Siemens-Martin steel. She has a circulating pump, steam feed and fire-pumps, and on deck are bilge and fire pumps, steam windlass, etc. All the living apartments and pilot-house are to be heated by steam, and ventilators are provided throughout.

THE new ferry-boat *Robert Garrett* for the Staten Island Rapid Transit Company was launched from the yard of the Columbian Iron Works, Baltimore, January 19. The boat has the following dimensions: Length between perpendiculars, 225 ft.; length over all, 236 ft.; breadth of beam, moulded, 36 ft.; breadth over guards, 64 ft.; depth of hull, 14 ft.; draft of water, including keel, 7 ft. 10 in.; draft of water from base line, 7 ft.; estimated displacement, 1,100 tons. The hull is of steel of 60,000 lbs. ultimate tensile strength, with a ductility of not less than 23 per cent., and an elastic limit of 35,000 lbs. The several parts are carefully proportioned, giving great strength where most needed. The plating at the water line is $\frac{3}{4}$ in. thick at the bow, tapering to $\frac{1}{2}$ in. amidships. Special attention has been paid to the strength of the bows to withstand the severe usage to which ferry-boats are subjected in entering the slips. The deck beams are of steel of the same quality. There are eight water-tight compartments in the hull, which are formed by five transverse and two longitudinal bulkheads, one of plate and angle steel, $\frac{1}{4}$ in. thick, braced with angle steel bars $3 \times 3 \times \frac{3}{8}$ in., each to have a water-tight door hung on strong hinges, and a sluice valve at keel. The longitudinal bulkheads run the length of the fire and engine-rooms and extend to the deck, stiffened by vertical angle bars 36 in. apart. The main deck is flush fore and aft, with four cabins and a central house built in the usual manner. Between the central house and the cabin on either side is a gangway. Over all comes the saloon deck, with saloon of large dimensions. It is covered in by the hurricane deck, except those portions extending over the porches of cabin below, which is left open as promenades. The engine is an inclined compound engine with cylinders 39 and 70 in. diameter and 60-in stroke. The cylinders are placed side by side and the cranks on the shaft are at right angles. The paddle-wheels are of the Morgan feathering pattern, made of unusual strength to provide against injury from ice. The boat has the Williamson steam steerer and has separate circulating, bilge, feed, and fire pumps. The two boilers are of the double-ended Scotch type, of steel, with four furnaces to each boiler. The boilers are 11 ft. 9 in. in diameter and 20 ft. long, and are intended to carry 100 lbs. working pressure.

Proceedings of Societies.

United States Naval Institute.

THE New York Branch of the United States Naval Institute held a called meeting in New York, February 9.

Captain A. P. Cooke, U. S. N., read a paper on the Naval Reserve and of the necessity for its organization, in which he discussed at length the relations of the Navy to the commercial marine, and declared that the armed ship and the armed sailor are necessities of our present civilization. The subject of Captain Cooke's paper was that the Navy should be considered as a normal school, supplying teachers to instruct and organize the seafaring population and those living along the coast, so that in case of necessity they might be prepared to undertake at once the duties which they might be called upon to assume in case of war.

The Naval Reserve should in some respects resemble the State Militia organization, but the conditions of its existence required that it should be under the control of the National and not of the State Government. He set forth at length an argument in favor of his plan, and sketched an outline for the organization for the reserve.

There was a large attendance of naval officers and of others interested in this question.

Master Car-Builders' Association.

THE following circular from M. N. Forney, Secretary, is dated New York, February 1:

"Arrangements have been made by the Executive Committee of the Master Car-Builders' Association, with the Ramapo Wheel & Foundry Company, to supply patterns of the Standard Christie Brake-Head and Shoe to members of the Association. The patterns are made of brass and are carefully finished, ready for moulding, with core boxes and lifters complete. They are intended to be used in the foundry for making castings for service, and allowance has been made for only one shrinkage.

"The prices for patterns will be as follows:

	Pattern for Brake-Head.	Pattern for Brake-Shoe.	Patterns for Brake-Head and Shoe.
For 33-in. wheels	$12.50	$7.00	$19.50
For 42-in. wheels	12.50	8 00	20.50

"These prices include boxing, f. o. b. at Ramapo. Orders should be addressed to the above-named Company at Ramapo, Rockland Co., N. Y."

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, February 1.

A paper by S. H. Chittenden, on the Work of Constructing a Dam Across the Potomac River for Increasing the Water-Supply of Washington, was read and was discussed by Messrs. Croes, Hutton, Flagg, and others.

Professor E. Muybridge, who was present as a visitor, showed some interesting specimens of his studies of the motions of men and animals by means of instantaneous photography.

The following elections were announced:

Members: Daniel Seymour Brinsmade, Birmingham, Conn.; Lorenzo Russell Clapp, Brooklyn, N. Y.; Frank Paul Davis, William Franklin Dennis, Washington; Clarence Delafield, New York; Edward Flad, St. Louis; Emil Gerber, Sioux City, Ia.; George Blagden Hazlehurst, Baltimore; Allen Bogardus Hegeman, Ottumwa, Ia.; Alexander Joseph Swift, Albany, N. Y.; Elliott H. Wilson, Butte City, Montana.

Juniors: Robert Ridgway, Sing Sing, N. Y.; Kayajiro Kobayashi, Kansas City, Mo.; George E. Moulthrop, Butte City, Montana.

A REGULAR meeting was held at the Society's House in New York, February 15.

Mr. T. C. Clarke made a statement of the results of the examination of the ceiling of the Assembly Chamber in the Capitol at Albany.

A paper by Gratz Mordecai, on the Classification of Railroad Accounts and the Analysis of Railroad Rates, was also read.

National Geographic Society.

AN Association to be known as the National Geographic Society has been incorporated in Washington. The object of this Society is to promote and increase the diffusion of geographic knowledge. The Society starts out with an enrollment of nearly 150 members.

The officers are as follows: President, Gardiner G. Hubbard; Vice-Presidents, H. G. Ogden, General A. W. Greeley, Commander J. R. Bartlett, Dr. C. H. Merriam, and Professor A. H. Thompson; Treasurer, Charles J. Bell; Recording Secretary, Henry Gannett; Corresponding Secretary, George A. Kennan; Managers, Professor J. C. Welling, Professor W. B. Powell, Captain Rogers Birney, Henry Mitchell, Marcus Baker, Cleveland Abbe, W. D. Johnson, and Professor G. Brown Goode.

The vice-presidents are to represent the several departments of geographical science. The board of managers will make arrangements for further meetings of the Society and for the general transaction of its work.

American Society of Mechanical Engineers.

THE following notice has been issued by the Secretary, Mr. F. R. Hutton, from his office, No. 280 Broadway, New York:

"Announcement is made hereby of the invitation which has been extended to the Society to hold its Spring Meeting of 1888 (XVIIth) in the city of Nashville, Tenn. This invitation has been accepted by the Council, and although the exact date has not been fixed, it will probably occur in the end of April or beginning of May, to secure the most favorable weather.

"The date of meeting coming this year earlier than usual renders it necessary for authors of papers to prepare their manuscript in early season. Several papers are promised already, but not enough to fill the docket. In arranging these details it is of great advantage to all concerned if early notice can be given of intention to contribute papers and of their titles. To secure under the approved practice of this Society the advance distribution of the papers among the members who will attend the convention, the *last* manuscripts for the meeting should be in hand before March 17, 1888.

"The Secretary will be glad to have as many of the papers as possible in print *before* that date, particularly if they are illustrated.

"Council meetings for the scrutiny of applications for membership occur at the end of February and of March. If possible, see that candidates in whom you are interested send in their applications for this meeting by the fifteenth day of those months.

"It is hoped that the location selected will command an interesting and large meeting, and the duty is urged upon those members who have extended practical experience to present parts of it in brief papers, to maintain the high standard of professional excellence for which the proceedings of this Society have become so favorably known."

Master Mechanics' Association.

THE following committee circulars have been issued by Mr. Angus Sinclair, Secretary, from his office, No. 175 Dearborn Street, Chicago:

RELATIVE PROPORTIONS OF CYLINDERS AND DRIVING WHEELS TO BOILERS.

What rule do you follow in designing boilers for Passenger, Freight, and Switching Engines? To illustrate the same, please give as examples, the heating surface of fire-box and flues, also grate and flue area necessary to give best results in each of the following cases, with bituminous coal of average quality:

1. Passenger Engine; Cylinder, 18×24 in.; mean diameter of driving wheels, 61 in.; speed, 40 miles per hour; cut off at 50 per cent. of stroke.

2. Freight Engine; Cylinders, 20×26 in.; mean diameter of driving wheels, 54 in.; speed, 25 miles per hour; cut off at 60 per cent. of stroke.

3. Switching Engines; Cylinders, 18×24 in.; mean diameter of driving wheels, 49 in.; speed, 8 miles per hour; cut off at 70 per cent. of stroke.

Boiler steam pressure in all cases assumed to be 160 lbs. and 7.5 lbs. of water evaporated by each pound of coal.

CHARLES BLACKWELL,
CLEM HACKNEY,
JOHN MCGRAYEL, } Committee.

Replies should be addressed to Charles Blackwell, care Angus Sinclair, Sec. Am. Ry. Master Mechanics' Association, 175 Dearborn Street, Chicago.

PREVENTION OF DANGEROUS ESCAPE OF LIVE COALS AND SPARKS FROM ASH-PANS.

Your Committee on subject No. 7 presents for consideration the following questions, and respectfully requests that your early attention be given the matter, and that such points as, in your individual opinion, will tend to improve the appliances, and the manner of handling the same, for the Prevention of Dangerous Escape of Live Coal and Sparks from Ash-Pans, be forwarded to the address of the Chairman.

We would also ask that at the same time you forward a blue print or other drawing, of your standard ash-pans for both passenger and freight engines, showing if possible the manner of attaching to the boiler and the arrangements of dampers, grate-shakers, and damper rigging. Also give the cost complete, ready for attaching to boiler, and if patented, state the amount of royalty per engine.

1. What proportion of the fires started on the right of way, bridges, trestles, or other structures of your line, do you attribute to having originated from fire dropped from the ash-pans?

2. What kind of fuel do you use?

3. What is the length of run of your express trains? What of your through freights?

4. Have you any special rule that you require the men to observe in handling dampers and grate-shakers, and using slash bars. If so, please send copy of same.

5. As a rule, how often is it necessary to clean ash-pans on an express run? How often on a freight run?

6. Have you any appliances not yet perfected that you think will tend to lessen the danger of fire from this source? If so, please furnish us with a sketch of same.

7. Have you had any experience with the so-called dumping ash-pans? If so, will you kindly give us the results of the same?

8. Do you consider it desirable to wet the ashes that accumulate in the ash-pans? If so, please describe your manner of accomplishing the same? If not, please give your reasons?

Should you be in possession of any data or information, not covered by this circular, that you think would be of service to the Committee, will you kindly send the same with replies as above?

G. W. ETTENGER,
E. D. ANDERSON,
W. H. THOMAS. } Committee.

Answers to these questions or correspondence about them to be sent to Mr. G. W. Ettenger, Master Mechanic, Newport News & Mississippi Valley Railroad, Richmond, Va.

TENDER TRUCKS.

1. Please give a description or blue-print of your standard tender truck and state if you use center and side bearings on both trucks?

2. Do you use the same truck for passenger and freight service?

3. Do you fit up your tender trucks with any more care or labor than you do your trucks for freight cars?

4. Do you run any heavy tenders in fast passenger service, and if so, have you found it necessary to design a special truck for this service?

5. If you have, please mention any points you have found defective in your ordinary truck, and your method of overcoming such defects.

6. Do you use a dust guard for your journal boxes; and if so, describe the kind giving the best results?

7. What is the size of your standard tender journal and axle?

8. What material do you consider the best for journal bearings?

9. What diameter and kind of wheels do you use in your tender trucks for the different kinds of service, and what diameter would you recommend for fast passenger service?

10. If you use steel-tired wheels, are you troubled with flange cutting, and to what do you attribute it?

11. In using steel-tired wheels, have you found that the life of the truck is lengthened, or that it requires less repairs because of the smoother running of the steel tires? If so, can you give any data?

12. What material do you prefer for axles, and what are your reasons for the preference?

We trust that all will respond to above queries, and contribute any other information that will be valuable to Committee in compiling report on this subject.

E. M. ROBERTS,
H. D. GARRETT, } Committee.
H. D. GORDON,

Answers to this circular should be addressed to E. M. Roberts, Ashland Coal & Iron Railway Co., Ashland, Ky.

PURIFICATION OR SOFTENING OF FEED WATER FOR USE IN BOILERS.

1. Have you experimented any with chemicals for the removal or prevention of scale in locomotive boilers?

2. Have you experimented any with mechanical devices for the same purpose?

3. Have you experimented any with chemical or other devices for purifying or softening water in water tanks before delivering the water to the locomotive tank?

4. Have you succeeded in preventing the formation of scale by means of surface blow-off cock?

5. If you have used chemicals inside of the boiler successfully, with what composition have you had the best success?

6. If you have used mechanical contrivances for softening or purifying water after it has been put in the boiler, please give the name by which the device is known which you used, and notes of your experience with it?

7. If you have used chemicals or other devices for purifying the water before being delivered to the locomotive tank, please give the name by which the device is known, and, if possible, furnish a cut or something illustrating the method employed; also describe the effects produced as far as your observations go?

8. Are you of the opinion that a mechanical device can be made which will thoroughly prevent the formation of scale after the water has been put into the boiler without being first purified?

9. Are you of the opinion that some chemical agent must be used after the water has been put in the boiler without being first purified, in order to prevent the formation of scale?

10. Do you think a combination of the chemical and mechanical contrivances more desirable?

11. If you can give any information or suggestions, regarding the purification of feed water, not elicited by the foregoing queries, please send them to the Committee.

HERBERT HACKNEY,
JOHN PLAYER, } Committee.
W. T. SMALL,

Replies to be addressed to Herbert Hackney, Atchison, Topeka & Santa Fé Railroad, Topeka, Kan.

TIRES; ADVANTAGE OR OTHERWISE OF USING THICK TIRES.

There are two methods of determining the relative value of thick as compared with thin tires. One is by making tests of the density of a number of specimens of each from the same maker, to determine whether the soft core is proportionally larger in one than the other. This method is misleading, and cannot be accepted as conclusive, since it has not yet been definitely established whether the rolling friction desired may not be greater in a soft tire, nor does this method take into account the elements other than relative density which cause abrasion of the tire surface, as the frequent use of sand, slip incident to curves, slipping on grades, over-cylindered engines, etc. The other is the crucial test of daily wear, and includes all the causes which combine to wear the tire. To make a reliable comparison of these values, the Committee require tabulated information showing the mileage made during the lifetime of a series of heavy and light tires of same makes, which the Committee request you to furnish upon blanks similar to the one herewith sent you.

In addition, please state:

1. Does the use of heavy tires increase the adhesion of the engine enough to appreciably reduce the quantity of sand required?

2. What observation have you made upon the influence the engineer exerts upon the wear of tires? Can his manner of handling the engine affect the lifetime of the tires to any great degree?

3. Do you consider it advisable or otherwise, to increase the weight of the driving-wheel centers beyond the actual weight necessary for strength and durability, in order to gain adhesive power, or would it be advisable to add such weight where it would be relieved by springs?

4. Do not heavy wheel centers with thick tires produce flat spots upon the tread of tires much sooner than light wheel centers and light tires?

5. Is your road heavily graded or comparatively level, and what is the character of the traffic? As to passenger, are trains run fast with frequent stops? Also, are your freight engines rated to a high maximum of cars per train?

The name of makers and comparative value of different makes of tire will be regarded as strictly confidential between the makers of reports and the Committee.

J. W. STOKES,
C. E. SMART, } Committee.
HENRY SCHLACKS,

Address replies to J. W. Stokes, Ohio & Mississippi Railroad, Pana, Ill. This circular is accompanied by a blank form for a record of wear of tires, which master mechanics are requested to fill up.

New England Water-Works Association.

AN adjourned meeting was held at Young's Hotel, Boston, January 10, President Darling in the chair. A number of new associate members were elected.

Mr. George A. Stacey, of Malden, was the first speaker. He spoke on the question of filtering. He said that it was time that some action was taken on the question. The population is increasing, which makes the question more important, and makes it necessary to discuss the topic, because it does not seem possible always to have pure water.

The Chair informed the speaker that Professor Leeds, of Hoboken, would read a paper on filtering at the annual meeting in June.

Mr. Stearns said that many towns are already drinking filtered water. He said that the board of health had obtained good results by filtration through sand.

President Darling gave a very interesting account of a manner of filtration applicable to works that have a dam. His system had done much for the purification and the removal of sediment from water. In his filter there were 268 ft. of material, and in a new one to be built he intended to have 2,000 ft. This filters 4,000,000 gallons a day. There is one at Lewiston, Me., but that one is buried. The one at Pawtucket can be seen, and President Darling extended an invitation to all superintendents to inspect it.

Mr. Horace Holden, of Nashua, described the works in his city.

Mr. Frank Fuller discussed the recording gauge in a very interesting and instructive manner.

Mr. A. H. Howland and Mr. Brown spoke on the same subject.

It was decided to resume regular monthly meetings.

Franklin Institute.

A STATED meeting of the Franklin Institute was held at the hall of the Institute in Philadelphia, December 21, President Joseph M. Wilson in the chair.

The Council reported that 17 new members had been elected since the last meeting. Nominations were presented for officers, managers, and members of the Committee of Science and Art, to serve for the ensuing year.

Mr. George S. Strong, of New York, presented a second communication on the Strong Locomotive, describing some improvements made in the details of its construction, and gave a summary of tests made by Mr. E. D. Leavitt. The paper was referred to the Committee on Publication.

Mr. F. S. Ives gave a brief sketch on the invention of what is known as the ether-oxygen lime-light, and described several methods which had been suggested for improving this light, and also some apparatus which he had invented.

Mr. W. S. Cooper then described and exhibited specimens of some improved sanitary appliances.

The Secretary, in his monthly report, referred to the recent trials of the Westinghouse brake for freight trains, and also described portions of the new life-saving apparatus invented by Mr. J. S. Dadia, and some useful products manufactured by Mr. W. L. Lance from the waste of oil-cloth.

Resolutions providing for enlarging the building of the Institute, making more space for the library, were discussed, but not favorably received.

The nominations submitted for officers were: President, Joseph M. Wilson; Vice-President, W. P. Tatham; Secretary, William H. Wahl; Treasurer, Samuel Sartain; Auditor, Lewis S. Ware; Managers, William Sellers, Cyrus Chambers, Jr., Hugo Bilgram, G. Morgan Eldridge, Henry R. Heyl, Charles Hare Hutchinson, Samuel R. Marshall, Charles E. Ronaldson; Members of the Committee on Science and the Arts, J. M. Emanuel, C. W. Howard, Professor L. B. Hall, John Haug, Henry R. Heyl, Fred E. Ives, W. M. McAllister, Philip Pistor, H. Pemberton, Jr., Thomas Shaw, Louis H. Spellier, Professor S. P. Sadtler, T. C. Search, W. Rodman Wharton, Otto C. Wolf, Moses G. Wilder. These officers have been elected.

Railway Superintendents' Association of Memphis.

THIS Association has been formed by the officers of the railroads running into the city of Memphis, Tenn. Its objects, however, are not technical, but simply to regulate the relations of those roads and the interchange of traffic.

The officers of the Association are: President, M. Burke, Mississippi & Tennessee; Vice-President, R. B. Pegram, Memphis & Charleston; Secretary, A. Gordon Jones, Memphis & Little Rock.

New England Railroad Club.

THE regular meeting was held in Boston, February 8, President Lauder in the chair. The subject for discussion was Wheels and Axles and their Relation to the Track.

Mr. Lobdell, of Wilmington, Del., spoke at length on chilled-iron wheels, treating the subject very thoroughly.

In the discussion following this address the merits of cast-iron wheels and the different patterns of steel-tired wheels were presented by Messrs. Adams, Laughlin, Coolbaugh, and others.

New York Railroad Club.

THE regular monthly meeting was held at the rooms in New York, January 19. Mr. H. H. Westinghouse, of the Westinghouse Brake Company, gave an account of the recent tests made with that company's 50-car train.

Some general discussion on the subject of brakes for freight trains followed.

Engineers' Club of Philadelphia.

THE meeting for December 17 was the decennial reception, on the tenth anniversary of the foundation of the Club. Concerning this Mr. Howard Murphy, Secretary and Treasurer, says:

"The Secretary is very glad to be able to announce to the members that both members and guests seem to have been much pleased with our little entertainment. It is almost impossible, we find, to exactly determine the number present, but it looks very much like 342. We were not, however, overcrowded, and, judging from the fragments that remained, everybody had enough to eat, —— and smoke. There was no speech-making or any attempt to introduce any feature which might have deprived the affair of an entirely informal and purely sociable character. It is believed that this entertainment will be of substantial and permanent benefit to the Club."

THE tenth annual meeting was held in Philadelphia, January 14. The retiring President, Mr. Thomas M. Cleeman, read the annual address.

The Tellers reported that the following had been elected:

Active Members: Messrs. Louis H. Parke, Barton H. Coffey, Agnew T. Dice, Simon C. Long, Jacques W. Redway, Samuel Bell, Jr., George W. Chance, Charles H. Haupt, George W. Creighton, Jawood Lukens, Alan Wood, Jr., Charles R. Hall, Robert A. Cummings, T. W. Simpson, General W. F. Smith, Charles Lukens, Herbert Bamber, and Barnabas H. Bartol.

Associate Members: Messrs. George T. Mills, Michael Clarkson, and A. J. Rudderow.

The Tellers also reported that the following officers had been elected for 1888: President, Joseph M. Wilson; Vice-President, J. T. Boyd; Secretary and Treasurer, Howard Murphy; Directors, T. M. Cleeman, L. M. Haupt, Frederic Graff, Washington Jones, and Henry G. Morris.

President Wilson, on taking the chair, made some appropriate remarks.

The reports of the officers showed total expenditures of $4,111, and a balance of $586 on hand. There are now 2 honorary, 462 active, and 11 associate members.

After the business meeting, Mr. A. Marichal read a paper on the Plan Formation of Quaker Bridge Dam. The topic of his discussion was the report, by the engineers in charge, to the Aqueduct Commission, on the non-advisability of constructing the dam on a curve. This was discussed by Mr. J. E. Codman.

Mr. H. S. Prichard presented an illustrated description of a Graphical Method of Determining the Deflection of Bridges.

A REGULAR meeting was held in Philadelphia, January 21, President Wilson in the chair.

The Secretary presented, for Mr. C. H. Ott, an account of a Peculiar Case of Transmission of Vibrations and Pulsations through Structures. Annoying, and even serious, vibrations, in this case, were found, by direct experiment, to be occasioned in a building at one end of a solid row 400 ft. long, by the operation of a small engine running a spice grinder in a retail grocery store at the other end of the row.

A general discussion of vibrations in structures followed, participated in by a large number of members, and numerous instances were noted.

Professor L. M. Haupt submitted a few extracts from the Report of the Chief of Engineers with reference to the Theoretical Operation of Submerged Jetties, and made some comments thereon to show why the system had apparently not proven more successful.

Mr. A. Marichal presented a mathematical discussion of the Theory of Curved Dams for the *Reference Book.*

Mr. F. W. Whiting noted a case in hydraulics, where attempt had been made to bring water in a pipe across an embankment, which had been unsuccessful until an opening was made at a point in the pipe line, and a small pipe extended therefrom to the level of the source.

Mr. Howard Murphy suggested that the trouble had probably been caused because the hydraulic gradient had not been considered in the original location of the main pipe.

A REGULAR meeting was held February 4. Professor Haupt submitted, with explanations, a bill now before Congress providing for the establishment of a Bureau of Harbors and Rivers, to be officered by a separate corps of civil engineers.

The Society adopted resolutions recommending the use of rain-gauges by the United States Signal Service.

Mr. A. Marichal read a paper on Rainfall, accompanied by diagrams and observations.

Resolutions relating to the publication of papers were, after discussion, referred to the Publication Committee.

A resolution that the Club adopt the 24-hour time system was postponed to the next business meeting.

Connecticut Association of Civil Engineers and Surveyors.

THE annual meeting was held in Hartford, January 10, President C. E. Chandler in the chair. The Secretary's report was read by D. S. Brinsmade, of Birmingham. The members of the Association, honorary, contributing, and active, number 89. The increase in membership, the sound financial basis, afforded in the mind of the Secretary good reason for congratulation.

He did not think the time was far distant when their increased facilities would allow a room of their own, with a library and other attractions.

President Chandler summed up the Association's prosperity in a brief address. He greatly urged the engineers to write. He said all had something to do, and could write about it. He added that all could systematize their work to this end.

Some business was done before the close of the first day's session, and these officers were chosen: President, C. H. Bunce, of Hartford; First Vice-President, E. F. Weld, of Waterbury; Second Vice-President, William B. Palmer, of Bridgeport; Secretary and Treasurer, D. S. Brinsmade, of Birmingham; Assistant Secretary, E. P. Augur, of Middletown. The Committee on Nominations brought in the following, who were elected: Executive Committee, C. Chandler, of Norwich; B. H. Hull, of Bridgeport; E. P. Augur, of Middletown; C. M. Jarvis, of Berlin; C. H. Bunce, of Hartford. Membership Committee, T. H. McKenzie, of Southington; H. G. Loomis, of Hartford; W. B. Palmer, of Bridgeport.

On the second day papers were read by E. P. Augur on the Adjustable Effluent Pipe of the Middletown Reservoir; by F. B. Durfey on the New Water Works at Bath, Me.; by F. W. Whitlock on Co-ordinate Surveying and Plotting, and by T. H. McKenzie on Mason Work.

The paper on Mason Work called out a long discussion, and there was also a discussion on the Rental Value of Hydrant Service.

Boston Society of Civil Engineers.

A REGULAR meeting of this Society was held December 21, 24 members and 3 visitors present.

Mr. Charles E. C. Breck was elected a member, and four names were proposed for membership.

A vote of thanks was tendered Mr. A. V. Abbott for the interesting description given at the last meeting of the superheated water system of Boston.

The government of the Society was authorized to make any arrangements it deemed advisable in relation to the coming meeting at Boston of the American Institute of Mining Engineers.

The Secretary read a paper prepared by George A. Ellis giving a description of the Racine Water Works.

Mr. M. M. Tidd occupied the rest of the evening, speaking in an informal way of the construction of dry docks.

A REGULAR meeting was held in Boston, January 18, President Rice in the chair; 31 members and 8 visitors present.

Messrs. Otis F. Clapp, Isaac K. Harris, D. W. Pratt, and Waterman Stone were elected members.

A communication was read from the Kansas Association of Engineers in relation to the interchange of papers. The President was authorized to reply to this communication in behalf of the Society.

The President announced the appointment by the Government of the following committee to extend courtesies to the American Institute of Mining Engineers at its coming meeting in Boston: H. L. F. Rice, William Jackson, Seth Perkins, Thomas J. Young, and W. S. Chaplin.

Mr. Jerome Sondericker read a paper on an Investigation as to how to Test the Strength of Cements. The paper was discussed by Messrs. Allen, Clarke, Lanza, Rice, Smith, and Stearns.

Engineers' Club of Kansas City.

THE first annual meeting was held at the Club's rooms in Kansas City, December 19. Reports of the Executive Committee, Secretary, Treasurer, and Librarian were read and approved. It was voted that for the ensuing year the offices of Secretary, Treasurer, and Librarian be united.

Nominations for officers were made, as follows: For President, William B. Knight, J. A. L. Waddell; for Vice-President, O. Chanute, A. J. Mason; for Secretary, Treasurer, and Librarian, Kenneth Allen, W. H. Breithaupt; for directors, T. F. Wynne, W. Kiersted, William B. Knight, W. H. Breithaupt.

Mr. Waddell read selections from his General Specifications for Highway Bridges of Iron and Steel, and requested that the Club endorse the objects of the paper.

On motion of Mr. Kiersted it was voted that the President appoint a committee of three members of the Club to consider the advisability of such action. Those appointed were Messrs. Chanute, Breithaupt, and Mason.

After a few remarks by Mr. Walker, of Cleveland, the Club adjourned.

At the meeting of January 9 the officers named above were elected. This meeting was followed by the annual supper.

A REGULAR meeting was held in Kansas City, February 6. Mr. A. Lasley, A. W. Boeke, and F. L. Mills were elected members. Mr. J. A. L. Waddell was declared elected Treasurer.

The committee appointed to consider Mr. Waddell's pamphlet on Highway Bridges presented their report. It was resolved to devote the regular meeting in April to the discussion of this subject.

Mr. B. L. Marsteller read a paper on Inspection of Iron Bridges and Viaducts. This was discussed by several of the members present.

Engineers' Club of St. Louis.

THE Club met in St. Louis, December 21, President Potter in the chair, 30 members and 2 visitors present. The Executive Committee announced the result of the ballot for officers as follows: President, M. L. Holman; Vice-President, J. A. Ockerson; Librarian, J. B. Johnson; Secretary, William H. Bryan; Treasurer, Charles W. Melcher; Directors, William B. Potter and F. E. Nipher.

The chair announced the election of the new officers, thanked the members for their co-operation in furthering the interests of the Club, and then appointed Messrs. Ockerson and Gale a committee to escort the new President to the chair. On taking his seat, Mr. Holman thanked the Club for the honor conferred upon him, and promised to perform his duties to the best of his ability. He then called upon the retiring President for some remarks appropriate to the occasion. Professor Potter addressed the Club on the present status of the profession and of the Engineers' Club of St. Louis in particular. His remarks were largely historical, and he suggested the appropriateness of celebrating the twentieth anniversary of the Club's formation, on November 4, 1888, by a social reunion of some kind. A printed catalogue of the Club's literature was suggested. The benefits resulting from the Association of Engineering Societies and the *Journal*, with its index department, were referred to. While a closer union of engineering societies might not yet appear desirable, he pointed out a number of ways in which co-operation might result in benefit to all. The question was commended to the thoughtful consideration of the Club.

The following amendment having been duly announced was then adopted unanimously:

"*Resolved*, That Section 2 of the by-laws be amended, by inserting after the words, 'and for non-resident members $4,' the following: 'Members elected after the last meeting in June shall have the option of paying $4 for the current year and receive the *Journal*, or $1 without the *Journal*.' "

On motion the Executive Committee was instructed to remit such part of the dues already charged to members elected since June last, as will give them the benefit of the amendment just adopted.

The Secretary then read a paper by Mr. Isaac A. Smith on Rapid Railroad Embankment Construction, being an account of the construction of an embankment in North St. Louis containing 97,500 cubic yards, within a period of 16 days. The material was river silt, and the cost 18.53 cents per cubic yard—but little more than half of the lowest bid received from contractors, none of whom would give a time guarantee. Messrs. Bryan and Wheeler took part in the discussion, in which it was shown that the shrinkage six months after was 11 per cent.

A vote of thanks was given Professor Potter for his address, which was ordered published. The address was discussed by Professor Johnson, Messrs. J. A. Seddon, Flad, and Holman.

Papers by Charles H. Ledlie and Professor Charles C. Brown were announced for the next meeting, January 4, 1888. Professor Engler called attention to an ingenious model of the hyperboloid of revolution.

A REGULAR meeting was held in St. Louis January 4, President Holman in the chair. Messrs. Robert H. McMath, J. W. Schaub, James M. Sherman, A. W. Hubbard, and Joseph F. Potter were elected members.

The paper by Mr. Charles H. Ledlie, entitled Construction of Dam and Reservoir at Athens, Ga., was then read by Professor Johnson. The method of carrying out the work was given in detail and sketches of the principal features were submitted. The protection of this kind of work against crawfish and musk-rats was shown to be of prime importance. Messrs. Moore, Holman, Johnson, and Flad took part in the discussion.

Professor Nipher then read a paper on The Volt, the Ohm, the Ampere—What Are They? being a mathematical discussion

of the subject. The results were shown and their value to the electrical engineer explained. The paper was illustrated by suitable apparatus and drawings. Messrs. Holman, Flad, Moore, and Seddon participated in the discussion.

A REGULAR meeting was held in St. Louis, January 18. Malverd A. Howe was elected a member.

The Secretary read a communication from the Civil Engineers' Association of Kansas on the subject of Interchange of Papers and Proceedings.

Professor Johnson called attention to a pamphlet by J. A. L. Waddell on the subject of Improvements in the Construction of Highway Bridges. It was ordered that a committee of three be appointed to consider same with a view to endorsing the author's ideas. The chair appointed as such committee J. B. Johnson, Robert Moore, and N. W. Eayrs.

Mr. N. W. Eayrs then read a paper on the Improvement of Nantucket Harbor, Mass.

The Secretary read a paper by Professor C. C. Brown, of Union College, Schenectady, N. Y., on State Surveys.

Professor Nipher exhibited another specimen of cast iron cap burst by hydraulic pressure caused by firing a rifle ball into a cylinder of water, the bottom of which was closed by the cap.

Mr. Crow exhibited an improved form of radial draw-bar as adapted for cable car service.

AT the meeting of February 1 the committee appointed to recommend suitable action on Mr. Waddell's efforts to reform present practice in the building of highway bridges reported as follows:

"*Resolved*, That this Club express their approval of the pamphlet entitled 'General Specifications for Highway Bridges of Iron and Steel,' by J. A. L. Waddell, and deem it a well-considered effort to bring about a much-needed reform.

"That we recommend these specifications to the consideration of county and town boards as calculated to give structures both safe and economical when faithfully carried out, but that to insure these results competent engineering supervision is absolutely necessary.

"That in the letting of highway bridge contracts and in the acceptance of the finished structures such boards should, in all cases, call to their aid a competent civil engineer, and thus insure at once the public safety and the wise expenditure of the public funds."

J. B. JOHNSON,
ROBERT MOORE, } Committee.
N. W. EAYRS,

The report was accepted and after discussion was laid on the table with notice that it would be called up in two weeks.

Resolutions were adopted recommending that the Signal Service stations be supplied with self-registering rain-gauges.

Mr. Carl Gayler then read a paper on Highway Bridge Floors, giving several standard designs, with their weights and cost

Mr. B. F. Crow read a paper on Constructive Accounts, showing how the cost of the material and labor required to produce each integral part of a street car is found, by means of labor and material accounts with all the orders. Both papers were discussed.

Minneapolis Society of Civil Engineers.

THE following officers have been elected for the ensuing year: President, W. A. Pike; Vice-President, E. B. Abbott; Secretary, Walter S. Pardee; Treasurer and Assistant Secretary, B. O. Huntress; Librarian, W. W. Redfield; Member of Board of the Association of Engineering Societies, Andrew Rinker; Membership Committee, Andrew Rinker, M. D. Rhame, and R. A. Sanford; Entertainment Committee, George W. Sturtevant and F. W. Chappelon; House Committee, W. W. Redfield and S. C. Deverly.

Illinois Society of Engineers and Surveyors.

THE third annual meeting was held in Springfield, Ill., January 25, 26, and 27. Three sessions each day were held, and the attendance throughout was large. The reports of the several officers and committees were submitted and acted upon, and numerous interesting papers were read by different members of the Society.

Senator Cullom's bill establishing a Bureau of Public Works was approved.

On Thursday, January 26, the Society went on special train on the Wabash Railway, by invitation of Charles Hansel, Chief Engineer, to the rolling mills and other points of interest.

A feature of the meeting was the exhibition of drawings, which was large, varied, and interesting. Thirty new members were elected, and the following officers were chosen for 1888: President, C. G. Elliott, Gilman; Vice-President, D. W. Mead, Rockford; Executive Secretary, Professor A. N. Talbot, Champaign; Recording Secretary, S. A. Bullard, Springfield; Treasurer, A. N. Talbot, Champaign; Executive Board, A. H. Bell, A. N. Talbot, E. A. Hill, G. P. Ela, C. G. Elliott.

The next meeting will be held in Bloomington, Ill.

Montana Society of Engineers.

THE annual meeting of this Society was held at Helena, Montana, January 21. The usual routine business was transacted and the meeting was followed by a banquet.

The following officers were elected for the ensuing year: President, George K. Reeder; Vice-Presidents, E. H. Wilson and E. A. Beckler; Treasurer, J. W. Wade; Secretary and Librarian, J. S. Keerl.

Indiana Society of Civil Engineers and Surveyors.

THE eighth annual meeting of the Indiana Society of Civil Engineers and Surveyors was held in Indianapolis, January 17, 18, and 19. The papers and reports submitted at this meeting were Drainage, by L. S. Alter; Topography, by Professor Phillips; the Relation of Astronomy to Surveying, by Professor C. A. Hargrave; Construction of Railroads and Bridges, by M. S. Fries; A New Transit and Wye-Level, by L. Beekman. There were discussions on several of these papers and also on other topics brought before the Society.

It was decided to hold the next meeting in Indianapolis, December 11, 1888.

The following officers were elected: President, J. C. Pulse, Greensburg; Vice-President, E. B. Vawter, Lafayette; Recording Secretary, J. E. Brown, Frankfort; Corresponding Secretary, G. M. Cheney, Logansport; Treasurer, R. L. Morrison, Knightstown.

Ohio Society of Surveyors and Civil Engineers.

THE ninth annual meeting was held in Columbus, O., January 10, 11, and 12, the attendance being larger than at any previous meeting. Twenty new members were elected.

On the first day the following papers were read: The Judicial Functions of the Surveyor, by Homer White; Adverse Possession, by E. D. Haselton; Steel Tapes as Standards, Professor J. B. Johnson; an address by George R. Gyger, on Protection from Incompetency, and a historical sketch of Our Public Domain, by J. T. Bruck.

The evening exercises were opened by the address of President W. H. Jennings. Dr. Edward Orton, of Ohio State University, gave a lecture on Road-making Materials of the State. Mr. C. A. Hanlon presented a paper on State Topographical Survey. The evening closed with a report of the Committee on Civil Engineering.

The afternoon of the second day was largely spent in discussing the material used in paving of streets and making of roads. A free exchange of opinion as to the merits of certain paving stones was made and considerable attention paid the manner of laying them.

A committee from the Centennial Commission, who waited upon the Society for the purpose of having a display of relics of the profession 100 years ago, at the coming centennial, was informed that their request would be complied with so far as was possible. The following papers were read during the day: Jonathan Arnett, on Philosophy of Underdrainage; Frank Kennedy, on the Catfish System of Drainage; G. S. Innis, on Construction of Turnpikes; Notes on Paving, by Thomas R. Wickenden; Cleveland City Pavements, by M. E. Rawson; Street-Crossings and Sidewalks, by R. A. Bryan; Street Grades and Records, by W. H. Jennings; Construction, Maintenance, and Repairs of Short-span Highway Bridges, by S. A. Buchanan; Computation of Strains in Highway Bridges, by Professor C. N. Brown; H. T. Lewis, on Bridge Details; Lifting and Moving of Bridges, by Thomas H. Johnson; Pile Foundations, by Julian Griggs; Masonry as Applied to Railroad Work, by A. G.

Pugh; Puzzles for the Enquirer, by W. A. Gain; Comparative Cost and Efficiency of Tile Drain and Open Ditches, by E. O. Opdycke; Street Grades and Monuments, by C. S. Lee; Monumenting, by F. Hodgman.

On the morning of the last day the reports of the retiring officers were submitted and approved, and papers were read and discussed by W. C. Rowe on the Circleville Water-works; by B. F. Bowen, on Mortar, and by William Reeder, on the Difficulties of Surveying in the Virginia Military District.

A petition signed by W. H. Jennings, Chief Engineer of the Hocking Valley Railroad, and nine other Columbus engineers, asking for permission to form a local association, was favorably acted upon. The Committee on Legislation reported in favor of abandoning the worthless portion of the Ohio Canal, but no action was taken on the report other than its acceptance.

The matter of an exhibit during the Centennial in Columbus in September was referred to the local members of the Association with power to act. The Committee on Legislation was instructed to formulate a bill to govern the qualifications of persons acting as civil engineers in this State, for presentation at the next annual meeting.

At the afternoon session J. N. Bradford, of Ohio State University, gave an illustrated lecture on Duplication of Blue Prints, and Mr. Cully read a paper on Landscape Engineering

The following officers were elected: President, J. D. Varney, Cleveland; Vice-President, O. B. Opdycke, Bryan; Secretary, C. N. Brown, Columbus; Treasurer, F. G. Sager, Columbus; Trustees, W. H. Jennings, Columbus; T. R. Wickenden, Toledo; F. M. Davidson, West Manchester; C. A. Judson, Sandusky; William Reeder, London.

Western Society of Engineers.

THE annual meeting was held in Chicago, January 3. The reports of the retiring officers were presented, and the following officers elected for the ensuing year are: President, A. Gottlieb; Vice-Presidents, John W. Weston, O. Chanute; Secretary, L. E. Cooley; Treasurer, W. S. Bates; Librarian, G. A. M. Liljencrantz; Trustee, O. B. Green.

The meeting was followed by the annual banquet, in which some 50 members participated, which was also made the occasion of a presentation from the Society to Mr. L. P. Morehouse, who for 18 years has been Secretary. The testimonial was a copy of the *Encyclopedia Britannica* in 24 volumes.

Civil Engineers' Society of St. Paul.

THE annual meeting was held in St. Paul, Minn., January 10. A paper was read by M. A. Munster upon Formula for Calculation of Plate-girders. A. Johnson, United States Assistant Engineer, read a paper on the Preservation of the Falls of St. Anthony, at Minneapolis, citing the work of 1883 done under the direction of Major C. J. Allen.

The following officers were elected for the ensuing year: President, C. F. Lowett; Vice-President, J. H. Morrison; Treasurer, J. C. L. Annan; Secretary, George L. Wilson; Librarian, A. Munster.

Civil Engineers' Association of Kansas.

THE adjourned annual meeting was held in Wichita, Kan., December 3. The following officers were elected for the ensuing year: President, Jerome C. Herring; Secretary, H. H. Hendershot; Librarian, R. W. Luttrell; Treasurer, H. H. Jackman; Executive Committee, R. H. Brown and W. R. Kessler. Twelve new members were elected and several applications received and referred.

A REGULAR meeting was held in Wichita, January 17. Three new members were elected. A number of communications were presented and acted on.

The Secretary was instructed to correspond with societies of like character with a view of identifying the interests and an interchange of proceedings.

Engineers' Society of Western Pennsylvania.

AT the annual meeting in Pittsburgh the following officers were elected for 1888: President, Alexander Dempster; Vice-President (two years), W. L. Scaife; Directors, T. P. Roberts, Charles Davis; Secretary, S. M. Wickersham; Treasurer, A. E. Frost.

OBITUARY.

BENJAMIN F. CRANE, who died in New York January 18, aged 71 years, was a civil engineer of long standing, and well known among the older members of the profession. He was born in Saratoga, N. Y., and served as assistant or resident engineer on the Erie Canal, the Croton Aqueduct, and the New York Central Railroad. He was the first Superintendent of the Central Park, New York City.

JOHN A. BAILEY, for many years Engineer of the Lighthouse Department, died in Marquette, Mich., January 22, aged 69 years. He entered the service of the Government in 1856, and had charge of the construction of many lighthouses along the Atlantic coast. He superintended laying the cable from Florida to Cuba; erected Spectacle Reef Light, in Lake Huron, in 1871. The last public work which he completed was the building of St. Annan Rock Light in Lake Superior. At the time of his death he was superintending the erection of the buildings of the Michigan Branch State prison at Marquette.

RICHARD EMERSON BUTTERWORTH, who died in Grand Rapids, Mich., January 17, aged 81 years, was born in Jamaica, West Indies. He was educated in England, and choosing the profession of an engineer, placed himself under the tuition of William Nicholson, of Manchester. He recalled the construction in 1830 of George Stephenson's locomotive, the *Rocket*, and was one of the party which rode upon it on its trial trip. For several years he was engaged at Manchester in the manufacture of cotton, but later settled in the United States. In 1875 he made the pumping-engines and machinery for the Grand Rapids water-works, and was also identified with similar undertakings in different parts of the country.

GEORGE H. CORLISS, the well-known manufacturer and mechanical engineer, died in Providence, R. I., February 21, of gastric fever, after a short illness. He was 71 years old. Mr. Corliss was born in Easton, N. Y., in 1817, and did not take up the profession in which he attained eminence until he was 25 years old. He went to Providence in 1844, in 1846 began the development of his steam-engine improvements, and in 1848 completed an engine which embodied the essential features of the present Corliss engine. Mr. Corliss had won a large number of medals and had many honors conferred upon him He carried away the highest competitive prize at the Paris Exhibition in 1867; was presented the Rumford Medals in 1870, the late Dr. Asa Gray, President of the Academy, making the presentation, and won the grand diploma at the Vienna Exhibition in 1873. Mr. Corliss was a Commissioner for Rhode Island at the Centennial Exhibition, and was one of the Executive Committee of seven that was intrusted with the preliminary work. His engine for transmitting the power all over Machinery Hall added to his fame. The undertaking cost him $100,000, and is the most princely gift ever given by an individual to such an exhibition. He was actively interested in public affairs, but the only offices he ever held were those of State Senator and Presidential Elector. The Corliss Engine, which is known all over the world established Mr. Corliss's fame, and it is through that engine that he will be remembered. He was, however, also very successful as the organizer and manager of a great manufacturing establishment.

PROFESSOR ASA GRAY, of Harvard University, died at his residence in Cambridge, Mass., January 30. He was born in Paris, N. Y., in 1810, and was graduated from Fairfield Medical College when he was 21, but soon left the practice of his profession for the field of botany. In 1836 he published his "Elements of Botany." When the University of Michigan was organized in 1838, he had already acquired such reputation as to cause his appointment to be Professor of Botany and Zoölogy. He took hold with a will, and got together a library of 4,000 volumes, having started the chair very well when in 1842 he was chosen Fisher Professor of Natural History at Harvard College, which position he retained until his death. The revolution in botany within his time, in which he has been one of the most able and important factors, has been entire; the artificial systems of Linnæus, De Candolle, and others (which were of great use in their day) had to give way to the natural methods which the exact observation of modern science demanded; and in this Gray was a leader. With Dr. John Torrey, who was his old teacher in medicine, he had begun in 1838 the great work, "The Flora of North America," which they carried together to the completion of the great order Compositæ. Dr. Torrey gave it up at this point, but Professor Gray

has continued to work upon it. He also published many other works on botany, besides delivering lectures, and published several works on the Darwinian theory of evolution. From 1863 to 1873 he was President of the American Academy of Arts and Sciences; and he was a member of most of the scientific societies of this country and a corresponding and honorary member of many abroad. He has not taught actively since 1873, but devoted himself to the charge of the herbarium and to scientific work. In 1874 he was appointed successor of Agassiz as a regent of the Smithsonian Institute at Washington. Professor Gray was widely esteemed, not only for his scientific attainments, but for his personal qualities.

PERSONALS.

J. R. GROVES has been appointed Superintendent of Rolling Stock of the St. Louis & San Francisco Railroad, with office at Springfield, Mo.

F. W. GERECKE is now Chief Engineer in charge of the Chicago Water-works. He is an engineer of much experience in that line.

GEORGE T. JARVIS, recently on the Mexican Central, has been appointed Superintendent of the Duluth, South Shore & Atlantic Railroad.

JOHN HERRON has been appointed Principal Assistant Engineer of the Montana Central Railroad, with office in Helena, Montana.

MAJOR CHARLES W. RAYMOND, U. S. Engineer, has been detailed to duty as Engineer Commissioner of the District of Columbia, replacing MAJOR WILLIAM LUDLOW, who is ordered to other duty.

OSCAR SANNE, late with the Dominion Bridge Company, is now Assistant Engineer of Bridges and Buildings of the Chicago, Milwaukee & St. Paul Railway.

J. F. O'ROURKE, of New York, has charge of the building of the foundations and piers of the new bridge over the Rio Grande at Laredo, Tex., for the Mexican National Railroad.

H. TANDY, recently of the Brooks Locomotive Works and formerly on the Grand Trunk road, has been appointed Superintendent of Motive Power of the New York, Ontario & Western Railroad.

T. J. NICHOLL, an engineer of long experience in railroad work, is now General Manager of the Natchez, Jackson & Columbus Railroad; his headquarters are at Natchez, Miss. The company proposes doing much new construction work during the present year.

PEYTON RANDOLPH succeeds Mr. E. B. Thomas as General Manager of the Richmond & Danville Railroad and its controlled lines. Mr. Randolph has been connected with the company for several years as Engineer, Superintendent, and Assistant General Manager.

E. B. THOMAS has been elected Second Vice-President of the New York, Lake Erie & Western Company, and will have especial charge of that company's New York, Pennsylvania & Ohio and Chicago & Atlantic lines. Mr. Thomas was formerly General Manager of the Cleveland, Columbus, Cincinnati & Indianapolis road, but has been for some time past Vice-President and General Manager of the Richmond & Danville.

CHARLES BLACKWELL, formerly with the Norfolk & Western, later on the Union Pacific, and for some time Manager of the Montana Union road, has been appointed Engineer of the Machinery Department of the Central Railroad of Georgia, with office in Savannah, Ga. Mr. Blackwell is well known as a mechanical engineer, and is an active and valued member of the Master Mechanics' and the Master Car-Builders' Associations.

COLONEL MARSHALL MCDONALD, who has been appointed United States Commissioner of Fisheries under the new law establishing the office as a distinct department, was for a number of years Professor in the Virginia Military Institute. In 1879 he was appointed Assistant to the late Professor Baird, and has since done much valuable work in connection with American fisheries.

JOHN W. FERGUSON, for 10 years past Assistant Engineer on the New York, Lake Erie & Western Railroad, has resigned his position to accept an engagement with the firm of Bernard Kelly & Sons, bridge and dock builders, of New York City. Mr. Ferguson will remain with the Erie a short time to complete the work of building a new draw-bridge over the Hackensack River, upon which he has been engaged for some time.

THE copartnership of WILSON BROTHERS & CO., of Philadelphia, civil engineers and architects, has expired. The old business will be settled by John A. Wilson and Joseph M. Wilson, and a new copartnership has been formed under the old firm name for the transaction of a general business as civil and hydraulic engineers and architects, by JOHN A. WILSON, JOSEPH M. WILSON, HENRY W. WILSON, CHARLES G. DARRACH, and HENRY A. MACOMB. The office is at 435 Chestnut Street, Philadelphia.

NOTES AND NEWS.

Mediæval and Modern Armor.— . . . . . In the middle of the seventeenth century armor had had its day.

And it has had its analogies. Have not we, in the last 25 years, repeated in another field three centuries of experiments? Were not the light cruisers of Drake and Hawkins circling about the huge Spanish galleons a foretaste of what may yet be to come?

When the *Merrimac* steamed down into Hampton Roads, crushing the *Congress* and the *Cumberland*, it was the barded knight destroying those lighter armed: and since then, in the armoring of ships, improvement has followed improvement.

In the old times the individual shut himself up in a shell, which he thickened and strengthened to resist projectiles, till, condemned to be immovable or risk the chances of bullets, he cast away his armor.

To-day instead of one, we shut up many in a floating iron shell. Every year sees a heavier gun and a heavier target. Again it is the costly knight whom a single shot sends down with all his wealth of armor. Shall we not, too, perhaps, with our great ships of war, cast off, as did the knight, first the greave and soleret that impeded the feet, then another and another piece of iron, till to the 140-ton gun we oppose only speed and activity?

If so, we shall have repeated the experience of the middle ages. The knights of Cressy and Agincourt will stand to us not merely as entertaining historical figures, but as teachers; and the faint echo of the splintering lances of the crusaders will come to us charged with a lesson.—*From "The Man-at-Arms," in Scribner's Magazine for February.*

American Pig Iron Production.—The *Bulletin* of the American Iron & Steel Association says: "The total production of pig iron in this country since 1880 has been as follows:

Years.	Gross Tons.	Years.	Gross Tons.
1880	3,835,191	1884	4,097,868
1881	4,144,254	1885	4,044,526
1882	4,623,323	1886	5,683,329
1883	4,595,510	1887	6,417,148

"Our production of pig iron in 1887, classified according to the fuel used, was as follows, in net tons, compared with the production in 1885 and 1886.

Fuel Used.	1885.	1886.	1887.
Bituminous	2,675,635	3,806,174	4,270,635
Anthracite	1,454,390	2,099,597	2,338,389
Charcoal	399,844	459,557	578,182

"The anthracite figures include all pig iron made with mixed anthracite and coke, as well as that made with anthracite alone. . . . .

"Our production of spiegeleisen in 1887, included in the figures already given of the total production of pig iron in that year, was almost exactly the same as in 1886. In 1886 it amounted to 47,982 net tons, and in 1887 to 47,598 net tons.

"The stocks of pig iron which were unsold in the hands of manufacturers or their agents at the close of 1887, and which were not intended for the consumption of the manufacturers, amounted to 337,617 net tons, against 264,717 net tons on June 30, 1887, and 252,704 net tons on December 31, 1886. In addition to unsold stocks in the hands of manufacturers at the close of 1887 there were also about 28,000 net tons of unsold pig iron in the hands of various other parties in Virginia, Pennsylvania, Alabama, Tennessee, and Michigan."

The Merced Irrigation Canal.—The opening of this California canal was recently celebrated at the reservoir near Merced, Cal., which has been named Lake Yosemite. This canal, which has been several years under construction and has cost $1,500,000, is 27 miles long, 100 ft. wide at the top, 70 ft. at the bottom, and 10 ft. deep. It will irrigate 300,000 acres of fertile land. It receives an inexhaustible supply of water from the Merced River flowing through the Yosemite Valley which is supplied by the snows of the Sierras. At a point two miles below the falls at Merced a dam raises the stream 10 ft. above its normal level. The great engineering features of the work are two tunnels, one 4,400 ft. long, driven through solid rock,

no supports being necessary ; the other, 3,000 ft. long, faced with timbers. The dam across the small valley near Merced, constructed to form a reservoir, is 4,000 ft. long, 275 ft. wide, and 54 ft. high. The level of the reservoir is 90 ft. above Merced. Water will be conveyed there in large pipes. It is believed the fall will be sufficient to run by water power flour mills and other manufacturing enterprises. Colonies will be settled along the line of the canal, which is the most important enterprise of a similar character ever carried to a successful termination in California.

Brick and Stone Bridges of Large Span.—Professor E. Dietrich, of Berlin, enumerates 57 bridges of brick or stone existing which have a span greater than 130 ft., and says that there are no others over that size. Of these bridges 33 are highway and 22 railroad bridges, one carries a canal, and one an aqueduct. Of the 57 there are 27 in France, 13 in Italy, 10 in England, two each in Austria and Spain, and one each in Germany, Switzerland, and the United States. The American bridge has the largest span of all—it is the Cabin John Bridge near Washington, which is a single arch of 237 ft. span. Of the 57 bridges only three others are over 200 ft. span ; 10 are between 164 and 200 ft., and 43 between 131 and 164 ft. Fourteen of them were built before 1800 ; 22 between 1800 and 1860 ; 5 between 1860 and 1870 ; 6 between 1870 and 1880, and the remaining 10 since 1880.

In 22 of these bridges the rise is between one-third and one-half the span ; in 18 between one-third and one-fourth ; in 10 between one-fourth and one-fifth, and in six between one-fifth and one-eighth. One bridge, in Turin, Italy, has a still flatter arch, the rise being in the proportion of 1 : 8.18 to the span.

Baltimore & Ohio Employes' Relief Association.—The November sheet of this Association shows payments of benefits to members as follows :

	Number.	Amount.
Accidental deaths	4	$3,500
Accidental injuries	337	5,040
Natural deaths	13	5,300
Sickness	549	8,566
Physicians' bills	186	1,676
Total	1,089	$24,082

The Association had paid out in benefits up to November 30 last the sum of $1,563,167 in all.

Accidents on Indian Railroads.—The *Indian Engineer* says : "The returns of accidents on Indian railroads during the first quarter of the year 1887 show that on an open mileage of 13,002 miles, with a train mileage of 11,765,517 miles, the total number of persons killed was 83, and of those injured 185. Of the number killed, however, 41 deaths occurred among persons unconnected with the railroads either as passengers or as servants, of which 4 were due to accidents at level-crossings, 34 due to persons trespassing on the lines and persons committing suicide, and 3 to unexplained causes ; while of the total number of persons injured, 16 were unconnected with the railroads, and received their injuries either through passing over level-crossings when trains were running, or from trespassing on the line.

"It is satisfactory to note that not a single passenger was killed, during the quarter, in a railroad accident, though 10 met their deaths through their own misconduct or want of caution, from falling when getting in or out of trains, falling out of carriages when trains were in motion, etc., and 11 injured through similar acts of carelessness or want of caution. In accidents proper, 47 passengers received injuries, 37 of whom were injured by collisions, 8 through trains or parts of trains leaving the rails, and 2 owing to accidents caused by obstructions on the lines. Accidents were more fatal to railroad servants than to passengers, 32 of the former having been killed during the quarter and 113 injured. The large majority of deaths (27 out of the 32) are, however, said to be due to misconduct or want of caution on the part of the persons killed ; while of the total number injured (113), no less than 103 have, according to the report, nothing to blame but their own carelessness for the injuries they have received."

A New British Cruiser.—The new steel twin-screw armored cruiser *Galatea*, which has been built and engined by Messrs. R. Napier & Sons, of Glasgow, has now completed her trial trips under both natural and forced draft. As first designed the *Galatea* and her sister ship, the *Australia*, were intended to have ordinary compound engines, but owing to the representations of Messrs. Napier, the Admiralty finally permitted engines of the triple-expansion type to be substituted, a change which has resulted in obtaining a speed of rather more than a knot in excess of that originally expected, while the weight of the machinery has not been increased. The natural draft trials were made in the Solent on November 9, when an average of 5,858 H.P. was indicated during the four hours' run, and a speed of 17.397 knots was obtained. The boilers steamed freely, an average pressure of 129.8 lbs. being maintained throughout the trial ; the engines made an average of 101.15 revolutions per minute, and the mean vacuum was 27.5 in. The forced draft trials took place November 11 under the superintendence of Mr. A. C. Kirk, the senior partner of Messrs. Napier & Sons. They commenced with a series of tests of the circle-turning qualities of the ship at full speed, and very satisfactory results were obtained. On the completion of these tests the trial proper was proceeded with, a series of runs being made on the measured mile in Stokes Bay, when a mean speed of 19.008 knots was obtained with an average of 9,205 indicated H.P. The mean pressure of steam in the boilers was 138 lbs., the vacuum 27.16 in., and the revolutions 113.5 per minute. Steam was blowing off throughout the trial, though the air pressure was only 1 in. on the water-gauge. The engines ran very smoothly, and no water was used on the bearings. The runs were made on a mean draft of 21 ft., which is what the *Galatea* will draw when completely equipped. During part of the run the engines indicated 9,664.5 H.P., and the mean for the last three hours was 9,414.10 indicated H.P. The machinery has been designed to work with maximum efficiency when at full power, and with forced draft, and under these conditions the coal consumption was 1.97 lbs. per indicated H.P. per hour ; under natural draft 2.3 lbs. per indicated H.P. per hour were consumed. The weight of the machinery was only 770 tons, or 1.67 cwt. per indicated H.P.—*London Engineering.*

Indian Frontier Railroads.—According to the telegraphic news from India, General Sir Frederick Roberts has been inspecting the road from Quetta to the Khojak Pass, which is being prepared in anticipation of a railroad being laid down along it in the spring in the direction of Candahar. The statesmen of both parties in England have an invincible objection to calling the proposed railroad by its right name ; the Liberals because they pulled up a section and sold the rails for old iron, and then had to lay it down again in a hurry, and the Conservatives because they are not quite sure the public approve of the policy that started the laying down of the Quetta Railway, and do not wish to excite undue alarm. On this account the line is commonly called "the Railroad to the Helmund," the river a little beyond Candahar, where, it is understood, we shall always make a stand against any northern invader. As politics may bring the line into prominence at any moment, it may be opportune to describe its present condition, in connection with its inspection by the Commander-in-Chief in India. From the River Indus the railway runs to Sibi at the mouth of the Bolan Pass. From this point, or close to it, there are two lines to the Quetta district ; one 100 miles long through the pass, which is spoiled by the break of the gauge, and will always be a poor line until this defect is remedied ; and the other a broad-gauge loop line 156 miles long, *viâ* the Hurnai crossing. The two join at Bostan, 21 miles beyond Quetta. From here a military road, 24 ft. wide, and with a minimum slope of 1 in 20, is being constructed as far as Chaman, an outpost on the Afghan side of the Kwaya Amran range, 70 miles from Candahar. The direct route to this point is not the easiest from the engineering point of view, and we have already had to censure the Indian Government for having procrastinated with its surveys, and caused thereby a standstill at Bostan, while the proper route for the next extension toward Candahar is being sought. At Quetta railway material is being accumulated sufficient to form a line the whole of the remaining distance to Candahar, so that it is sheer affectation and cant to treat the line as otherwise than the future Candahar Railway. Although it is only this week that regular goods traffic has been opened to Bostan, so much merchandise is already pouring into the place that if our Chambers of Commerce were as enterprising as the German trading bodies, this would soon bring pressure to bear upon the Government to complete the line to the emporium of Candahar. In that case the Quetta line would rapidly become a paying undertaking.—*London Engineering.*

Telephonic Communication at Sea.—Mr. H. F. Boyer, of H.M.S. *Malabar*, has recently made a number of experiments in this direction with an apparatus of his own invention. Previous attempts of the same general character by some American electricians have been described. The following description is given of the arrangement : The source of sound consists of a large gong or flat bell supported against the side of the vessel below the water line. A straight tube leads from this gong to the bridge of the ship, and in its interior is a rod fitted with a handle at its upper end, by which the hammer of the gong can

be worked, and the gong struck at will. The striking of the gong may, of course, be done in keeping with a code of signals, such as the Morse code used in ordinary telegraphy. In the center of the gong is fixed a modified Bell telephone with a large and sensitive diaphragm. The telephone is connected by means of wires running up the tube to a second telephone on the bridge within reach of the observer there. This forms the receiving part of the apparatus. If we suppose two ships fitted with this combination, it is only necessary for one to rap out her message by striking the gong and for the other to receive it on her telephone. The sound waves from the transmitting gong traverse the intervening water and vibrate the diaphragm of the submerged telephone at a distance. These vibrations excite currents in the latter, which, in traversing the second or observing telephone, reproduce the original sounds of the gong. Small explosions of gun-cotton under water have also been used by Mr. Boyer in place of the gong; and an ounce of gun-cotton can in this way give a signal which is distinctly heard a mile off under water. Such signals under the sea are independent of fogs or stormy weather; and they hold out the possibility of lighthouses and lightships being able to signal vessels at all times. Moreover, ships, in addition to signaling each other, could also signal lightships, or announce their number to Lloyd's stations, if the system prove successful. Mr. Boyer's plan, which so far has given encouraging results, is somewhat similar to that of Professor Lucien J. Blake, of the Rose Polytechnic Institute, United States. Instead of a submerged telephone, however, it will be remembered that Professor Blake uses a microphone in circuit with the deck telephone as a receiver. With this arrangement Professor Blake has been able to transmit subaqueous signals from a locomotive bell through 1½ miles of the Wabash River, comprising three or four windings. Mr. Edison also is reported to have signaled through a mile of the Caloosahatchie River in Florida during the present year. His system has not been fully disclosed, but it appears to be similar to those described. It is to be hoped that this new development of telephony will be pushed as far as possible.—*London Electrician.*

The International Petroleum Exhibition.—The International Petroleum Exhibition at St. Petersburg, under charge of the Imperial Russian Technical Society, was opened December 27. The London *Engineering* says: "The original intention was to open it December 1, but so many foreign firms applied for permission to fit up installations that the inauguration had to be postponed. The exhibits promise to be of a most elaborate character. Messrs. Nobel, who, by the way, have now $15,000,000 invested at Baku, will show a miniature exhibition of the entire petroleum industry, from the boring of the rock for oil to the manufacturing processes, and the distribution in bulk by tank steamers, tank cars, and street tank wagons. Other firms will illustrate the manufacture of machinery, oil, candles from paraffine, the preparation of dyes from oil refuse, and other technical branches of the industry. One of the most interesting exhibits, however, promises to be a collection of lamps of every age, from those discovered in the tombs of Egypt, Greece, and Rome to the latest productions of Europe. To collect these, the museums of Russia have been ransacked by a commission appointed by the Imperial Archæological Society. The display of modern lamps will be also extremely interesting, the offer of prizes for the best safety paraffine and kerosene lamps having caused exhibits to crowd in from every part of the world. We may note, as an instance of the competition English manufacturers may expect, that the Russian firm of Kumberg will show no fewer than 140 different types of lamps. Gas companies should be interested by the display of different systems of illumination by crude oil, paraffine, and oil flares of the Lucigen description. Numerous furnaces will be also fitted up to show the different methods of using liquid fuel. Among the members on the committee are Professor Mendalaeff, who is regarded as the greatest living authority upon petroleum, and a number of scientific men are expected to attend from Germany, France, and Belgium; England being represented among others by Mr. Charles Marvin, whose articles on the Russian petroleum industry three years ago may still be remembered. In general, English lamp manufacturers have displayed great readiness in sending exhibits; but we do not hear of any particular displays by builders of tank steamers, manufacturers of pipes and pumps, and tank cars for railways. As the Germans and Belgians are very freely represented, it is to be trusted that no branch of the industry will ignore an exhibition which, during its three months' existence, will probably be visited by persons interested in petroleum from all parts of Europe."

We are not aware that the United States will be represented in any way. The Russian producers of petroleum are now making great efforts to introduce their oil in the European markets, and this exhibition is intended to call attention to their products.

New Transatlantic Steamers.—The latest designs in Transatlantic steamers are those of two steamers now under construction for the Inman Line between New York and Liverpool, which have longitudinal as well as transverse bulkheads, and twin screws. These vessels—the *City of New York* and the *City of Paris*—are subdivided into many compartments, and there are no doors in the bulkheads below the level of the upper deck. The vessels are sister ships, and are 525 ft. long on the water line, or 560 ft. over all, 63½ ft. beam, and 42 ft. moulded depth. Their gross tonnage will be 10,000 tons each. They will have four complete decks—promenade, upper, main, and lower, with partial deck above promenade deck and partial deck below the lower deck. The number of complete transverse water-tight bulkheads, all of which are without doors, is 14, so that the average length of each compartment will be 35 ft., or a little more than one-half the breadth of the vessel. But the large dimensions of these ships render even such a compartment one of considerable size, so that there will be no possibility of cramped spaces. The new steamers are fitted with two sets of engines, each set driving a separate screw. The engines are in two separate compartments, subdivided by a water-tight bulkhead, and the boilers are in three separate compartments, completely cut off from each other, so that these vessels might be in collision by being struck on any bulkhead, and could have a break-down in their machinery such as may occur in any ordinary ship, and still be quite navigable and thoroughly safe and seaworthy. While, therefore, the vessels are well provided against the effects of collision, they are also very much better able to avoid collision by having two sets of machinery, one of which could be readily reversed while the other was going ahead, thus turning the vessel.

With the view of avoiding delay outside the bar at New York or Liverpool these vessels have been designed for a light draft; but as it is necessary to have proper immersion for their screws the lightness of draft necessary for crossing the bar will be obtained by the use of water ballast in the double bottom which has been fitted throughout their length. These double bottoms are built upon a new principle specially designed by their constructors, and are believed to be stronger and lighter than anything of the kind which has preceded them. Each has a capacity for 1,500 tons of water in the double bottom, which weight is available for purposes of immersion or stability at the wish of the commander. These double bottoms, it is hardly necessary to say, are a double precaution against injury by grounding. It is anticipated that by the adoption of the precautions of light draft and ample trimming power, the vessels will never have to wait outside the bar at New York. A departure in the machinery department of these vessels is made in the adoption of forced draft on the closed stokehole system, similar to that which has been applied to so many war ships. By the adoption of this system the space and weight occupied by machinery has been considerably reduced, with a considerable increase in cargo and passenger-carrying space.

In order to secure the rapid dispatch and shipment of cargo and coal the vessels will be fitted throughout with hydraulic appliances worked by two independent sets of engines, one in each engine-room, so that in the event of accident to one the other will be at once automatically set in motion. There will be in all 13 hydraulic lifts for cargoes, four for engineers' and firemen's use, and two for steward's use. The steering gear will be worked by hydraulics, and also the cable. The great advantage of this system, so far as the comfort of the passengers is concerned, consists in its complete noiselessness; and any one who has slept, or tried to sleep, on board a steamer when landing cargo by an ordinary steam winch will thoroughly appreciate this advantage. The vessels will have three masts and three funnels; but excepting in the remote contingency of a complete break-down of their machinery, it is not at all likely that sails will ever be set on these vessels. Some of the largest Transatlantic liners, on account of the dimensions which the necessities of the case have forced upon them, are very bad rollers. The dimensions of these vessels are not likely to involve them in defect of this kind; but to provide for the possibility of occasionally meeting seas which may make them roll badly, they will be provided with a rolling chamber, which is really a large tank inside the vessel, extending from side to side, and partially filled with water. The partial filling enables the water to move about freely, and when the dimensions of this chamber and its form are properly selected, the motion of the water can be made to counteract the motion of the ship when rolling. The constructors of these vessels have, after a long series of experiments both on models and in actual Atlantic work, arrived at a form of chamber which will, it is calculated, reduce the rolling by at least one-half.